Chapter 5.3.1 - South Bay Aqueduct

Potential Contaminant Source or Watershed Activity	Report Section	Water Quality Parameters								
		TDS/ Salts	Organic Carbon	Bromide	Pesticides	Nutrients	Pathogens	Trace Elements	Turbidity	T&O
Recreation	5.3.1.1									
Wastewater Treatment/Facilities	5.3.1.2		○			○	○		○	
Urban Runoff	5.3.1.3	○	○		○	○	○	○	○	
Animal Populations	5.3.1.4					◒	◒		○	
Algal Blooms	5.3.1.5								●	●
Agricultural Activities	5.3.1.6									
Traffic Accidents/Spills	5.3.1.7									
Geologic Hazards	5.3.1.8					○	○		○	

Rating symbols:

● PCS is a highly significant threat to drinking water quality

◒ PCS is a medium threat to drinking water quality

☉ PCS is a potential threat, but available information is inadequate to rate the threat

○ PCS is a minor threat to drinking water quality

Blank cells indicate PCS not a source of contaminant

Chapter 5.3.2 - Lake Del Valle

Potential Contaminant Source or Watershed Activity	Report Section	Water Quality Parameters									
		TDS/ Salts	Organic Carbon	Bromide	Pesticides	Nutrients	Pathogens	Trace Elements	Turbidity	T&O	Other
Recreation	5.3.2.1						◒		◒		● 1
Wastewater Treatment/Facilities	5.3.2.2		◒			◒	◒				
Urban Runoff	5.3.2.3				○	○	○		○		
Animal Populations	5.3.2.4					○	◒		○		
Algal Blooms	5.3.2.5								◒	◒	
Agricultural Activities	5.3.2.6				○						
Mines	5.3.2.7	○						○			
Unauthorized Activity	5.3.2.8										
Traffic Accidents/Spills	5.3.2.9										
Geologic Hazards	5.3.2.10					○	○		○		
Fires	5.3.2.11										
Land Use Changes	5.3.2.12								●		● 2

Rating symbols:

● PCS is a highly significant threat to drinking water quality

◒ PCS is a medium threat to drinking water quality

⊙ PCS is a potential threat, but available information is inadequate to rate the threat

○ PCS is a minor threat to drinking water quality

Blank cells indicate PCS not a source of contaminant

Notes:

1. MTBE
2. Threat of erosion from development,grading, etc

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South Bay Aqueduct and Lake Del Valle

This chapter addresses the South Bay Aqueduct (SBA) and Lake Del Valle as separate but highly related State Water Project (SWP) features. Discussion of potential contaminant sources (PCSs) for the SBA focuses on the aqueduct's open portions, which include about 10.7 miles of open canal. A separate discussion of Lake Del Valle's PCSs is warranted because its watershed and activities call for distinct evaluation and development of conclusions and recommendations.

5.1 WATERSHED DESCRIPTION

The SBA begins at Bethany Reservoir along the western edge of the San Joaquin Valley, traverses the hills surrounding Altamont Pass and descends into the Livermore Valley. The SBA flows along the eastern and southern edges of the valley, south of the City of Livermore and the Lawrence Livermore National Laboratory. Through much of the Livermore Valley, the aqueduct is an open canal. The SBA has approximately 10.7 miles of open canal sections, which present the greatest potential for contamination.

Lake Del Valle is approximately 11 miles from the City of Livermore, which has a population of 74,303 as of January 2000 (DOF 2000). The watershed of Lake Del Valle encompasses approximately 130 square miles (95,300 acres) of rugged, hilly terrain. The reservoir has an extensive watershed with a number of significant tributary streams that contribute substantial annual runoff to the SBA supply. Precipitation in the area is typical of the Coast Ranges in this vicinity and occurs mainly as rainfall between the months of October and May. Average annual precipitation in the Lake Del Valle watershed varies with elevation, ranging from 16 inches at lake elevation to 36 inches in the higher elevations surrounding Mount Eylar (DWR 1974).

5.1.1 LAND USE

5.1.1.1 South Bay Aqueduct

The vast majority of Alameda County's agricultural land is used as rangeland (Livermore 1997). Grazing is the main agricultural practice in the upland areas. Land surrounding the open canal sections is undeveloped and used as rangeland. In Livermore Valley, orchards, rangeland, and vineyards typify the area's agriculture. Approximately 2,100 acres of vines grow in the south Livermore Valley, and several commercial wineries operate in the vicinity of the SBA. The SBA skirts the southern edge of the valley, an area that is experiencing rapid urban expansion. Most of the Livermore Valley land immediately surrounding the SBA is governed by Williamson Act contracts, which restrict land use to agriculture for a minimum period of 10 years (Livermore 1997).

5.1.1.2 Lake Del Valle

Much of the Lake Del Valle watershed remains in a natural, undeveloped state. Major land uses are recreation associated with Lake Del Valle and cattle-grazing in the upland areas. There are no other significant land uses, and very little has changed since the Del Valle Dam was built in 1968 (Budzinski pers. comm. 2000).

The watershed contains about 95,000 acres, including about 4,000 for the park area. Much of the land surrounding the lake and within the watershed is privately owned, with many of the parcels divided into large plots. In 1974, 73% of the basin (about 70,000 acres) were owned by 30 landowners, each with more than 640 acres (DWR 1974). Naftzger-N3 Cattle Company, the largest landowner in the watershed, operates a ranch southeast of the recreation area surrounding Lake Del Valle. Naftzger lands extend farther southeast into the watershed, constituting a large portion of the area along Arroyo Valle. Patterson Trust owns a substantial portion of the land immediately adjacent to the Lake Del Valle State Recreation Area (SRA) also has operations adjacent to the northern edge of the lake. Other significant private landowners are the Walker, Sachau, and Minoggio families. In 1990, there were reported to be approximately 160 private residences in the upper portion of the watershed (Brown and Caldwell 1990).

5.1.2 GEOLOGY AND SOILS

5.1.2.1 South Bay Aqueduct

Soils near open SBA canals are somewhat similar to the Lake Del Valle watershed, consisting of both valley and upland types. Soil types include Clear Lake clay and Danville clay loam in the flatter areas and Zamora, Positas, and Diablo silt and clay loams in sloped areas (Livermore 1997). The SBA is surrounded by some relatively flat areas and numerous rolling hills with slopes ranging from gentle to steep. Runoff potential in sloped areas ranges from medium to rapid with moderate to severe erosion hazards.

5.1.2.2 Lake Del Valle

Lake Del Valle's watershed lies within the Diablo Range and encompasses several rock types in both the Great Valley Geomorphic Province and the California Coast Ranges. The dam and a majority of the lake are on the Upper Cretaceous Panoche Formation of the Great Valley Geomorphic Province (DWR 1996). The upper watershed overlies the Franciscan Formation composed of Gray Wacke, minor clay shale, and chert interbeds with some metamorphic rocks (DWR 1979). Soils in this watershed can be broken into 2 main types—upland soils and valley soils. Upland soils cover the majority of the watershed and are predominately Gaviota, Vallecitos, Parrish, Shedd, and Henneke series (DWR 1974). Valley soils, which occur mainly in the San Antonio and Upper San Antonio valleys in the upper portion of the Arroyo Valle drainage basin, are composed of various types of alluvium, including the Yolo, Hillgate, Garretson, San Ysidro, Cortina, Zamora, Clear Lake, and Positas series (DWR 1974).

Elevation in the Lake Del Valle watershed ranges from about 700 feet to more than 4,000 feet. A substantial portion of the watershed has slopes greater than 30% (DWR 1974). Soils in the area are generally shallow. Depth of the upland soils ranges from approximately 6 to 42 inches. With its shallow soils and steep slopes, the land in the Del Valle drainage basin is highly erodible. About 80% of the land has severe erosion hazards. Landslides in various stages cover approximately 77% of the Lake Del Valle watershed (DWR 1974). About 20% of the drainage basin lie in flat areas around the lake and the San Antonio Valley.

There are several active faults in the SBA and Lake Del Valle areas. The Livermore fault intersects the SBA near mile marker 18, passes within 800 feet of the Del Valle Dam, and then continues south approximately 3 miles, skirting the eastern edge of the lake. The Williams and Valle faults are in the area (DWR 1979). Active faults in the area include the Greenville fault, 6 miles east of Lake Del Valle; the Calaveras fault, 8 miles west of Lake Del Valle; the Hayward fault, 20 miles west of Lake Del Valle; and the San Andreas Fault, 55 miles west of Lake Del Valle (DWR 1996a).

5.1.3 VEGETATION AND WILDLIFE

Regional vegetation is predominately foothill woodlands and grasses (DWR 1996). The riparian areas and north-facing slopes support stands of California live oak, blue oak, valley oak, and digger pines (DWR 1974). Cottonwood and sycamore trees are found along portions of the Arroyo Valle drainage. Native needle grass and spear grass occupy the areas between wooded stands.

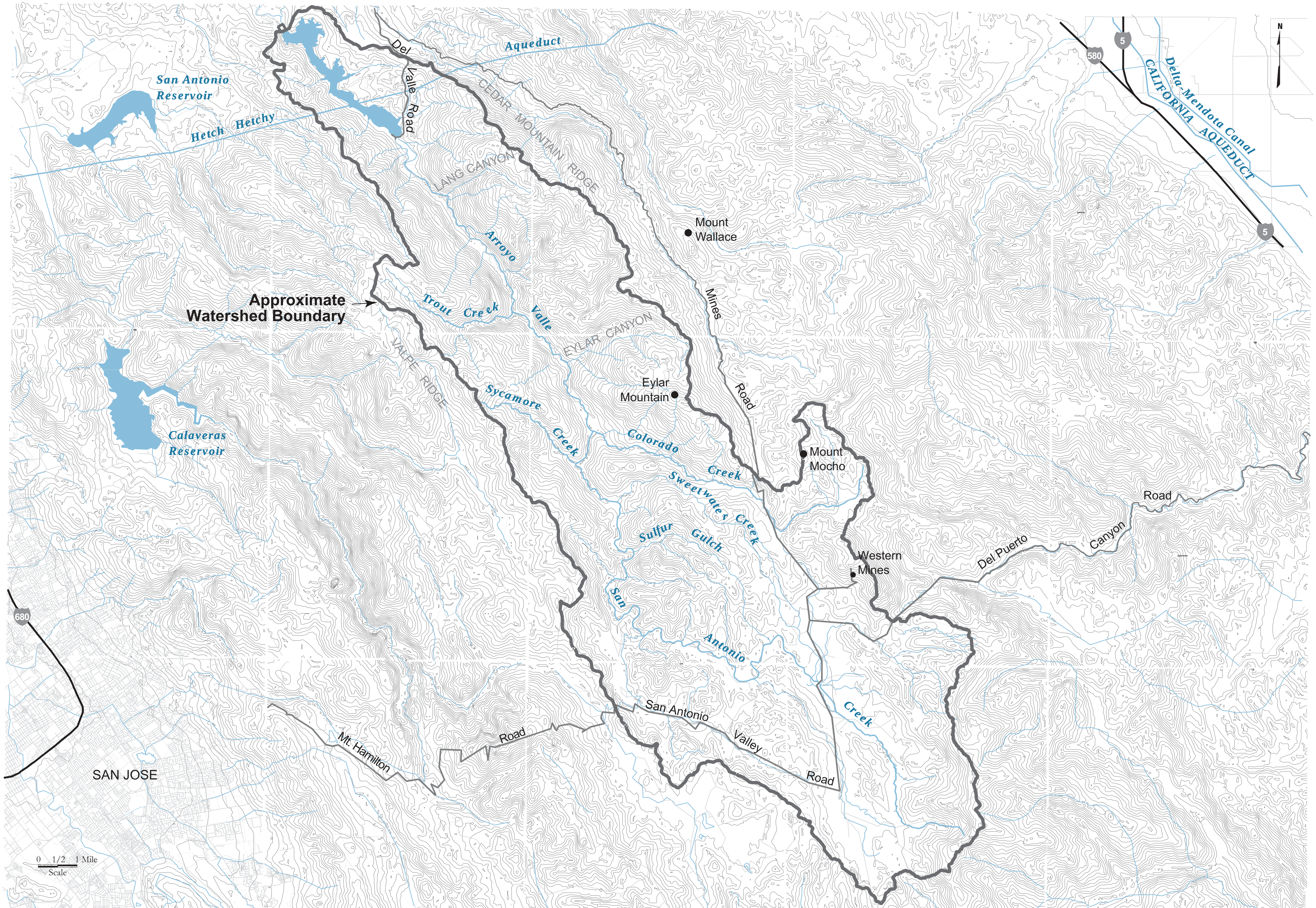
The region is home to many avian, mammalian, amphibian, and reptilian species. The extensive expanses of relatively unspoiled habitat provide for large populations of some species. Mammalian species common in the region include blacktailed deer, feral goats, wild pig, rabbits, hares, and ground squirrels (DWR 1974). Other small mammals include weasels, skunks, gray fox, coyotes, badgers, and bobcats. Mountain lions and opossum are also found in the region. Avian species include the game birds quail and doves, which frequent the stands of oak surrounding Lake Del Valle. Woodpeckers, swallows, jays, wrens, warblers, blackbirds, and finches are all found in the region.

5.1.4 HYDROLOGY

Two sources of inflow—SWP water from the SBA and natural inflows from the watershed—supply Lake Del Valle. During summer months, SWP water is pumped into the reservoir to maintain reservoir elevations suitable for recreational uses; and in the fall, the water is released to provide flood control capacity. SBA inflows and outflows from 1996 to 1999 are discussed in Section 5.2, Water Supply System.

The major stream draining Lake Del Valle's watershed is Arroyo Valle, which drains an area of approximately 130 square miles. Since most of the precipitation occurs in the winter, Arroyo Valle flows from October through July in normal rainfall years (DWR 1996). Important stream tributaries to Arroyo Valle include Trout Creek, Sycamore Creek, Colorado Creek, Sweetwater Creek, and San Antonio Creek (Figure 5-1). Colorado and Sweetwater creeks drain the southeastern portion of the watershed farther down Mines Road, where there are magnesium mines containing high hardness and alkalinity levels.

Figure 5-1 Lake Del Valle Watershed Area



Natural inflows constituted a large portion of the total inflow to Lake Del Valle (Table 5-1). From 1996 to 1999, natural inflows were between 74% and 100% of the total lake inflow. A considerable amount of year-to-year variation in natural inflow volume can be explained by the heavy precipitation during the El Niño storms of 1998. However, annual variation can be observed in historical data. The flow in Arroyo Valle near the damsite prior to its construction in 1958 was 80,780 acre-feet. In 1961, the flow dropped to 807 acre-feet (DWR 1974).

Table 5-1 Total Annual Natural Inflows to Lake Del Valle (acre-feet)

1996	1997	1998	1999
60,806	47,276	87,265	15,375

Source: DWR, Division of Operations and Maintenance, SWP Operations Data 1996 to 1999

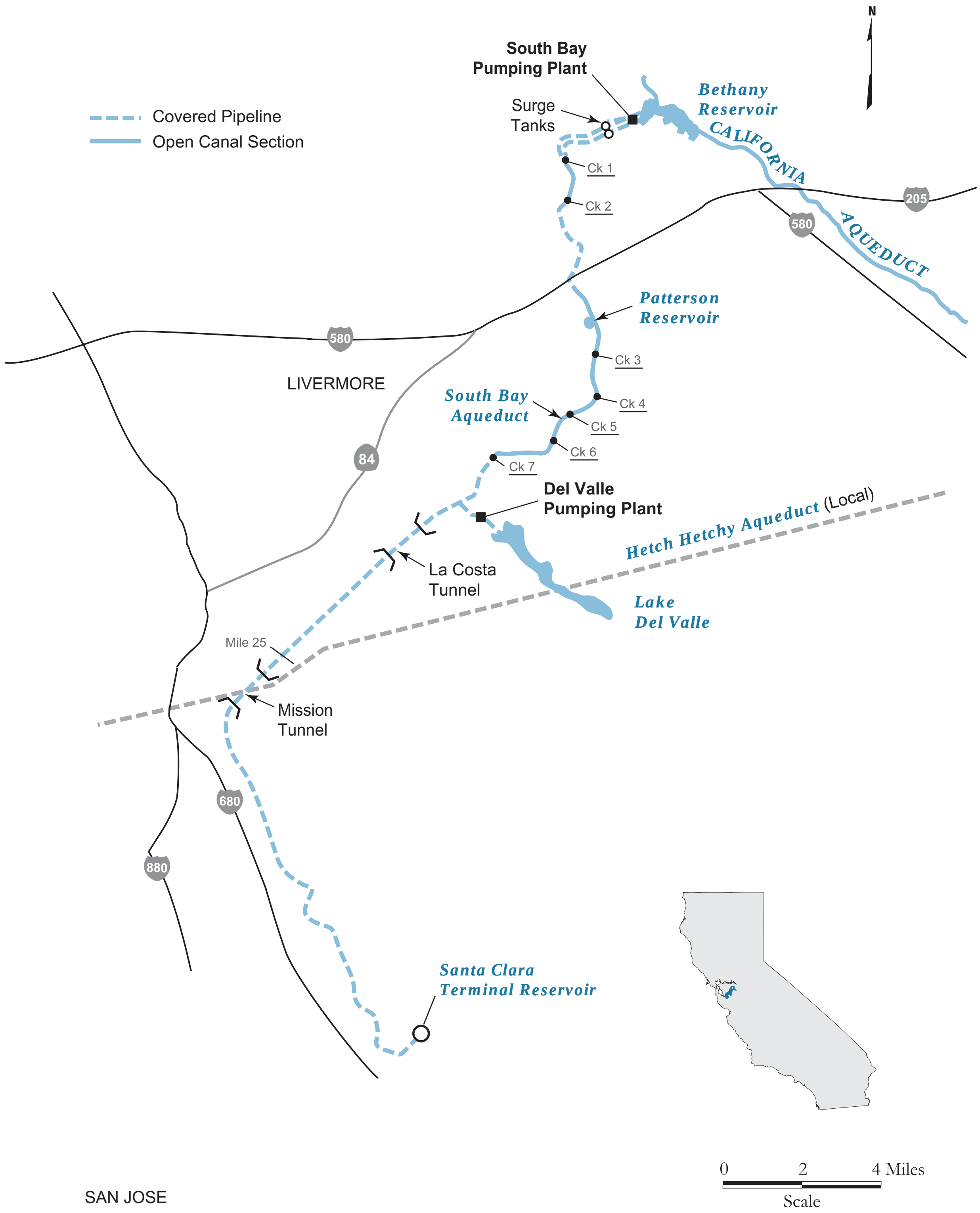
Lake Del Valle is near the southern margin of the Amador groundwater subbasin and within the alluvial basin of Arroyo Valle. In 1995, groundwater elevations in the alluvial basin area ranged from 20 to 30 feet (Livermore 1997).

5.2 WATER SUPPLY SYSTEM

5.2.1 DESCRIPTION OF AQUEDUCT/SWP FACILITIES

Open canals and underground pipelines alternate along the 43-mile long SBA (Figure 5-2). At the upper end of Bethany Reservoir, South Bay Pumping Plant, with a pump capacity of 330 cfs, lifts SWP water 566 feet into the 1st reach of the aqueduct (Brown and Caldwell 1990). For about the first 3 miles, the SBA is a pipeline. From mile 3.26 to 5.21, it is an open canal that begins with a surge pool and has a copper sulfate ($CuSO_4$) feeding facility for algae control. From mile 7.42 to 16.38, the SBA is open canal with a turnout at mile 9.49 for Patterson Reservoir, a raw water storage facility with a capacity of 100 acre-feet. Along the remainder of this open section there are 2 more copper sulfate feeding facilities. The SBA continues as a pipeline from mile 16.38 through the La Costa and Mission tunnels to mile 42.26 and its terminus at the Santa Clara Terminal Reservoir, an uncovered 2.5-million gallon steel tank.

Figure 5-2 South Bay Aqueduct



Aside from its main canal and control gates and pumps, the SBA contains a number of structures that are PCSs as shown in Table 5-2 and discussed in Section 5.3, Potential Contaminant Sources.

Table 5-2 Description of Structures in Open Canal Sections of the SBA

Structure description	Total
Drain Inlets	27
Canal roadside drainage	16
Agriculture drainage	11
Groundwater	0
Other	0
Bridges	11
State	0
County	2
Farm or Private	9
Overcrossings	14
Pipelines	12
Overchutes	2
Undercrossings	26
Drainage	26
Irrigation or domestic	0
Water-Service Turnouts	20
Irrigation pumped upslope	3
Other	17
Fishing Areas	0

At mile 18.63, a 60-inch turnout serves as a common inlet/outlet for Lake Del Valle. Del Valle Pumping Plant with its 4 pumps and 120 cfs capacity supplies Lake Del Valle with SWP water. Lake Del Valle is formed by the 235-foot high Del Valle Dam, which was constructed in 1968. The multipurpose reservoir has a storage capacity of 77,100 acre-feet and a potential surface area of 1,060 acres. It provides water supply, flood control, and year-round recreational activities. As stated in Section 5.1, Watershed Description, the reservoir has an extensive watershed that contributes annual runoff, helping to replace losses from natural evaporation, percolation, and some of the domestic uses for recreation amenities.

Reservoir water can be released into the SBA to supply SWP contractor needs, to meet streamflow requirements for water rights in Arroyo Valle, or to recharge groundwater in Livermore Valley and along Alameda Creek (DWR 1974). At the end of summer, the lake level is lowered to create capacity for flood control. During the wet season, natural watershed inflows in excess of downstream water rights are impounded. Additional water is pumped from the SBA as necessary to maintain the reservoir at 40,000 acre-feet from April to October. Flood control storage is used only during times of high runoff in Arroyo Valle, and the stored water is released in a relatively short period of time. During summer recreation season, the lake is usually maintained at an elevation of 703 feet, which gives it 40,000 acre-feet of storage volume, 715 acres of water surface area, and 5 miles of length with 16 miles of shoreline (DWR 1974).

Inflow and outflow for the SBA and Lake Del Valle from 1996 through 1999 are presented in Table 5-3. Inflows for the SBA are from South Bay Pumping Plant; outflows are measured as the total volume of deliveries. Inflows for Lake Del Valle include both natural watershed source, which is primarily Arroyo Valle, and pump-ins from the SBA; outflows include total releases into the SBA and Arroyo Valle and deliveries to East Bay Regional Park District (EBRPD).

Table 5-3 SWP Inflow/Outflow for the SBA and Lake Del Valle (acre-feet)

SWP Location	1996	1997	1998	1999
SBA:				
South Bay PP (Inflow)	77,023	109,610	78,136	117,115
Outflow (Deliveries)	106,282	126,006	103,234	125,513
Lake Del Valle:				
Inflow: From SBA	0	3,434	0	4,062
From Natural	60,806	47,276	87,265	15,375
Outflow (Total releases)[a]	55,835	51,924	86,886	12,771

Source: DWR, Division of Operations and Maintenance, SWP Operations Data 1996 to 1999
[a] To SBA, Arroyo Valle, EBRPD

Although from 1996 through 1999, SBA outflows always exceeded inflows, the volumes were generally similar and averaged 115,259 and 95,471 acre-feet, respectively. Total deliveries during this period were substantially less than the maximum potential annual entitlement of 188,000 acre-feet for the 3 SWP contractors.

At Lake Del Valle, nearly all of the total inflow in all years was from natural sources, and the volume of inflows exceeded outflows in 3 of the 4 years evaluated. These inflows were also a large percentage of the reservoir volume of 77,100 acre-feet, comprising 79%, 61%, and 113% of this volume in 1996, 1997, and 1998, respectively. SWP inflows to Lake Del Valle ranged from 0% of total reservoir inflow in 1996 to 21% of total reservoir inflow in 1999. These data suggest that water quality in the SBA during reservoir-release periods in 1996 through 1999, and in 1998 in particular, was highly influenced by the natural inflows from the watershed.

5.2.2 Description of Agencies Using SWP Water

SWP water is withdrawn along the SBA at several locations and distributed to 3 agencies (in order of SBA intake): the Alameda County Flood Control and Water Conservation District-Zone 7 (Zone 7), the Alameda County Water District (ACWD), and the Santa Clara Valley Water District (SCVWD). The current SWP entitlements for each agency are Zone 7, 42,000 acre-feet; ACWD, 46,000 acre-feet; and SCVWD, 100,000 acre-feet (DWR 2000b).

5.2.2.1 Zone 7

Zone 7 is 1 of 10 active zones of the Alameda County Flood Control and Water Conservation District, a public agency established by voters in 1949 to solve the county's problems of flooding, drainage, channel erosion, and water supply. Zone 7 includes all of eastern Alameda County, consisting of about 425 square miles and occupying a major portion of the Alameda Creek watershed. The area has a population of about 172,000 and includes the cities of Dublin, Livermore, and Pleasanton and the communities of Sunol, Altamont, and Mountain House. Much of Zone 7 activity is in the Livermore and Amador valleys and includes small areas of the cities of Fremont, Union City, and Hayward (Zone 7 1999).

Zone 7 has 2 water treatment plants (WTPs): the Patterson Pass WTP, which receives 100% Delta water, and the Del Valle WTP, which receives both Delta water and water released from Lake Del Valle. Each receives most or all of its supply from the SBA. The turnout for Patterson Pass WTP is at mile 9.49, prior to the connection with Del Valle Reservoir at mile 18.63. Del Valle WTP turnout is at mile 19.20 (Deol pers. comm.).

The Patterson Pass WTP, constructed in 1962, has a capacity of 12-million gallons per day (mgd); the Del Valle WTP, constructed in 1975, has a capacity of 36 mgd. Both are in Livermore. Raw SBA water entering the Del Valle and Patterson Pass WTPs goes through a number of treatment processes. Mixing/coagulation begins the process of turbidity removal. Coagulants such as alum (aluminum sulfate) or ferric chloride and special polymers are rapidly mixed with the water during the flocculation/sedimentation process, causing them to form larger particles, or "floc." The water moves slowly through a large basin so flocs can sink to the bottom for removal of 70% to 90% of suspended matter by sedimentation. At the Del Valle WTP, flocs are removed midway through the basin by a special "superpulsation" process (Deol pers. comm. 2000).

The filtration process further removes particles as well as pathogens. The water passes through a dual-media filter made of sand and anthracite coal. After the filtration process, protozoan pathogens such as *Giardia* and *Cryptosporidium* and nearly 100% of suspended matter are removed. In 1997, Zone 7 installed particle counters at both of its treatment plants to monitor filtration effectiveness.

Chlorine is the primary disinfectant, and chloramines (chlorine/ammonia combination) are added to maintain disinfection after the water leaves the treatment plant and enters the distribution system. Chloramines also help prevent the additional formation of disinfection byproducts (DBPs).

5.2.2.2 ACWD

The ACWD has supplied water to residents and businesses in southern Alameda County for more than 85 years. The service area has changed from being an important agricultural center to supporting a growing suburban population. ACWD supplies drinking water to more than 318,000 people living in the cities of Fremont, Newark, and Union City. The SBA provides about 55% of the total ACWD water supply.

ACWD operates 2 WTPs, which use 100% SBA water and are in the City of Fremont. The Mission San Jose WTP, also known as WTP1, is off Vargas Road above Mission San Jose and began operating in 1975. Water Treatment Plant Number 2 (WTP2), a state-of-the-art facility on Mission Boulevard near Interstate 680, was put into operation in 1993. WTP1 has a capacity of 8.5 mgd and is a conventional surface water treatment plant using coagulation and sedimentation, dual-media filtration, and chlorine for disinfection. WTP2 has a capacity of 21 mgd in winter and 28 mgd in summer, when water quality improves, and is the district's newest and most advanced treatment plant. The intake turnouts on the SBA for these WTPs are very close, WTP1 at mile 28.96 and WTP2 at mile 28.97, so source water quality for both plants is considered the same (Marchand pers. comm.).

Water is delivered to WTP2 via a 3-foot diameter pipeline. Because of the elevation difference between the aqueduct and the treatment plant, ACWD installed turbines to generate electricity. This hydroelectric facility produces enough electricity to run all the treatment processes, including ozone generation. Ozone is the primary disinfectant and is applied to the plant influent. In addition to being a highly effective disinfectant, the ozonation process destroys compounds that can cause unpleasant taste and odor in finished water. After ozonation, coagulants are added, and the water goes to flocculation basins for mixing and settling of particles prior to sedimentation. Following sedimentation, the clarified water is filtered via dual-media anthracite coal and sand. A vacuum system removes the settled solids to a solids holding basin. The finished water receives a small dose of chlorine prior to entering the distribution system. The pH is also adjusted for corrosion control, and fluoride is added (Bradanini pers. comm. 2000).

ACWD is in the process of making significant upgrades at both plants to reduce DBPs. WTP2 is going to acid addition to reduce high bromate levels associated with ozonation. ACWD has engaged a consultant to provide the design. Based on handling safety, the district will probably use carbonic acid, not sulfuric acid. ACWD expects this system to be implemented this year. WTP1 still chlorinates, but plans are to go to ultrafiltration to reduce TOC levels and, therefore, DBPs. ACWD is currently receiving bids for construction and estimates upgrades to take about 18 months to complete (ACWD 2000a).

5.2.2.3 SCVWD

The SCVWD is a special district created by public vote, governed by a 7-member board of directors, and responsible for water supply, flood protection, and watershed management in Santa Clara County. The SCVWD encompasses all of the county's 1,300 square miles and serves the area's 15 cities, 1.7 million residents, and more than 200,000 commuters. The district has 2 missions: to provide high quality water and to manage flood and storm water along the county's 700 miles of creeks and rivers.

Imported water makes up more than half of Santa Clara County's supply. Both imported water and groundwater are sold to the 13 water retail agencies that supply most of the communities in Santa Clara County. The SCVWD receives water from the SWP and federal Central Valley Project (CVP) and supplies water to local water retail agencies, such as San Jose Water Company and the City of Milpitas.

The SCVWD operates 3 WTPs in its service area. The Penitencia WTP, which went online in July 1974, was selected for this report because it receives 100% SWP water and predominantly SBA water. It also receives SWP/CVP water from San Luis Reservoir. The Penitencia WTP is in the east San Jose foothills and has a capacity of 40 mgd. It receives SBA water from the Santa Clara Terminal Reservoir Tank at mile 42.26. The WTP uses conventional treatment processes including coagulation/flocculation, flow-through sedimentation, and multimedia filtration. Disinfection is accomplished using chlorination (SCVWD 2000a).

SCVWD initiated a major project to upgrade all of its WTPs. The project will be completed in 2 phases and is intended to help the WTPs comply with Stage 1 Disinfectant/Disinfection Byproducts (D/DBPs) Rule and Interim Enhanced Surface Water Treatment Rule (IESWTR), while maintaining a safe and reliable system and aesthetically pleasing water. Phase 1 improvements include adding new potassium permanganate chemical facilities, replacing the storage and feed system for the existing powdered activated carbon systems with new storage and feed systems, and reviewing and upgrading an existing alum primary coagulant chemical system to enable use of either alum or another primary coagulant, ferric chloride. Phase 2 improvements are longer term and include conversion of the disinfection process from chlorination to ozone and changing filter media to improve the ability to remove biological organisms (SCVWD 1999).

5.3 POTENTIAL CONTAMINANT SOURCES

5.3.1 SOUTH BAY AQUEDUCT

This section focuses on major known or suspected PCSs along the open portions of SBA from approximately mile 3.27 to 16.28 (Figure 5-2).

5.3.1.1 Recreation

There is no authorized recreation along the open portions of the SBA (Gage pers. comm. 2001a). This is not considered a significant contaminant source.

5.3.1.2 Wastewater Treatment/Facilities

There are no known or reported wastewater treatment plants or effluent discharges in this section of the SBA.

Septic Systems

There is an old septic tank and leach field at South Bay Pumping Plant that has been pumped periodically to avoid overflowing into nearby intake. The system only requires occasional pumping—it has not been pumped since 1993—and no sewage overflows have occurred (Scheele pers. comm. 2000). This system is not considered a significant potential source of pathogens.

5.3.1.3 Urban Runoff

Land around the open SBA sections is mostly agricultural, used as grazing for cattle. There is little urban development. Runoff from surrounding hillsides can enter the open portions of the SBA primarily through drain inlets, overcrossings, and bridges (Brown and Caldwell 1990). As in the Lake Del Valle area, soils in this area are generally erodible to highly erodible. The various inlets collect runoff, which can be a source of turbidity, pathogens, and nutrients. The most significant source of runoff is from cattle-grazing areas adjacent to the SBA and from the bridges used to cross the aqueduct, as discussed in Section 5.3.1.4, Animal Populations.

Of the 27 drain inlets identified in Table 5-2, 16 convey drainage from the canal right of way. The remaining 11 drain inlets bring runoff from livestock grazing areas in addition to canal bank drainage. Overcrossings convey runoff from one side of the aqueduct to the other and are potential sources of contaminants associated with adjacent land use activities. Most of the overcrossings are associated with oil industry pipelines varying from 12 to 30 inches in diameter; there were no reports of problems with any of these pipelines on the SBA. *Sanitary Survey 1990* reported that there was a large drain inlet at South Bay Pumping Plant receiving runoff from several hundred acres of land (Brown and Caldwell 1990). See discussion in the following section.

5.3.1.4 Animal Populations

Livestock Grazing

Depending on rainfall, the grazing season usually occurs from November through June to take advantage of new forage growth. Cattle graze along the open portions of the SBA, and during rainfall, the runoff from these areas can enter the aqueduct via drain inlets. There is also substantial grazing on the western shore of Bethany Reservoir (Gage pers. comm. 2000). Grazing is considered a significant potential source of pathogens and nutrients in the SBA. The inlet area around South Bay Pumping Plant also receives runoff from land used extensively for cattle-grazing.

Wooden bridges used by cattle to cross the aqueduct were routes for contamination. Large gaps in the wooden planks allowed cattle droppings to directly enter the aqueduct. These planks have been replaced with sealed flooring to reduce threats to water quality.

5.3.1.5 Algal Blooms

All SBA contractors consistently cite taste and odor problems produced by 2-methylisoborneol (MIB) and geosmin as a significant water quality concern. Certain algal species produce high concentrations of these malodorant compounds. The canal has green algae problems in summer associated with Delta water from the Harvey O. Banks Pumping Plant, along with films of blue-green algae that grow on the side of the canal, resulting in complaints from the SBA contractors (Janik pers. comm.). Additional taste and odor problems occur following the application of copper sulfate, which results in cell death and the eventual release of MIB and geosmin (Deol pers. comm. 2001).

Taste and odor problems generally occur in summer months when conditions are suitable for algal blooms. SWP Delta water supplied by Banks Pumping Plant is enriched with nutrients, and algal growth occurs in Clifton Court Forebay. The algae continue to grow in the SBA open canal especially under the right water temperature and light conditions (Gage pers. comm. 2000). Discussions with staff at DWR's Delta Field Division indicate that most of the algae responsible for taste and odor problems is thought to originate in the Delta and not the SBA (Gage pers. comm. 2001a). Because algae are present in source waters, algal growth in treatment plant basins further contributes to taste and odor problems (SCVWD 2000).

Algal growth is also known to occur in the SBA through data that at times show geosmin levels in the canal exceed those found at Banks Pumping Plant (Janik pers. comm. 2001). Geosmin is produced in the SBA in higher concentrations than MIB, although it not known why. Blue-green algae species found in the SBA include *Oscillatoria* sp., a known geosmin producer, and *Synecchococcus* sp.

Algal blooms have created operational problems for SBA contractors as well. Following some DWR applications of copper sulfate, SBA contractors have reported filter clogging from the large masses of decaying algae (Deol pers. comm. 2001; Brewster pers. comm. 2001; ACWD 2000). Prior to the year 2000, DWR staff added copper sulfate to control algae in the SBA on an as-needed basis, although this was done largely to control the green alga, *Cladophora* sp., which reportedly does not produce taste and odor (Janik pers. comm). This meant that copper sulfate was often added after an algal bloom had occurred and algal populations had reached high levels.

In 2000, SBA contractors and DWR's Division of Operations and Maintenance (O&M) agreed on an improved approach to better control taste and odor problems. The approach is the direct measurement of taste and odor compounds using Closed Loop Stripping Analysis (CLSA) at key sample locations with a fast turn-around time for results. Data are distributed to SBA contractors by e-mail, usually within 1 to 3 days of collection. DWR and SBA contractors use these data to modify water delivery and WTP operations when taste and odor compounds exceed threshold values. In May 2000, O&M began adding a lower concentration of copper sulfate (1.25 mg/L, down from 2.5 mg/L in 1999) every other week until October when copper sulfate additions were stopped (Janik 2000). Beginning and ending dates were based on water temperature (Gage pers. comm. 2001). Although the copper sulfate additions were primarily for control of *Cladophora*, a non-taste and odor producer, all SBA plants evaluated for this report noted an improvement with taste and odor problems in summer 2000. More data are needed, however, to appraise the success of this procedure (Brewster pers. comm. 2001a; Deol pers. comm. 2001; and Hidas pers. comms. 2001).

Aquatic weed growth in the canal is removed mechanically. In Bethany Reservoir, aquatic weed growth is treated with Komeen, an aquatic herbicide, and some weeds are removed mechanically.

Sanitary Survey 1990 also reported that persistent Asiatic clams were a problem in the SBA (Brown and Caldwell 1990).

5.3.1.6 Agricultural Activities

Agriculture is a substantial land use in the area of the SBA. Grapes are a major crop, especially in the area northeast and northwest of Del Valle Dam. Orchards and grazing are the other significant activities in this area (Livermore 1997).

Vineyards were reported as agricultural land use of potential concern along the SBA, and the number of vineyards is increasing (Zone 7 2000). The majority of vineyards appear to be out of the immediate drainage area of the SBA, farther west and north in the valley. Vineyards in the drainage area of the SBA drain into culverts that go underneath the SBA and would not affect water quality (Gage pers. comm. 2001a).

5.3.1.7 Traffic Accidents/Spills

Transportation Corridors

There are 2 major corridors in the Livermore Valley area that cross the SBA and have the potential for runoff and spills to enter the aqueduct (Figure 5-2). There is also some potential runoff from nearby Interstate 580 where it crosses the SBA above Patterson Reservoir near the beginning of the open aqueduct section (Zone 7 2000).

History of Accidents/Spills

DWR field personnel reported that there were no known accidents or spills that could affect drinking water supplies during this period (Gage pers. comm. 2000).

5.3.1.8 Geologic Hazards

There are several major active faults in the immediate area (within 10 miles), including the Livermore, Williams, Valle, Greenville, and Calaveras faults. Farther away are very significant faults including the Hayward fault and the San Andreas Fault (DWR 1996a). Five earthquakes of a 4.0 or larger magnitude have occurred in the area since the turn of the century; the strongest had a magnitude 5.5 (DWR 1979).

If the SBA sustained earthquake damage, deliveries would likely halt. This would create a serious water supply problem for SBA contractors. Many overcrossings convey runoff from one side of the aqueduct to the other. Most are associated with oil industry pipelines varying from 12 to 30 inches in diameter, and during a significant seismic event petroleum-related contaminants—or those associated with adjacent land use activities such as nutrients, pathogens, and turbidity—could be introduced into the SBA.

5.3.2 LAKE DEL VALLE

5.3.2.1 Recreation

The Davis-Dolwig Act of 1961 and State Water Code § 11900 require that the purposes of SWP facilities shall include recreation and the enhancement of fish and wildlife habitat as well as water storage. In keeping with this mandate, recreation activities at Lake Del Valle include many reservoir body-contact and nonbody-contact activities.

Lake Del Valle has a surface area of about 1,060 acres, and its shoreline is developed for numerous types of recreation. The Del Valle Regional Park area includes about 4,000 acres. Developed recreation areas are reachable by automobile, boating, and hiking. Body-contact recreation at the lake includes swimming, wind surfing, and boating. Nonbody-contact recreation includes camping, picnicking, horseback riding, hiking, and fishing (DWR 1996). Recreational areas also have parking, potable water and sanitary facilities, and food, gas, and oil retail. Fishing, swimming, and boating are the major water recreation uses. Water skiing is not allowed. Park services are open all year with both group and family campgrounds available, as well as day use and hiking areas.

The recreational activities are potential sources of contaminants for several reasons:
Contribution of feces from body contact recreation such as swimming,

- Introduction of pathogens by horses,
- Fuel spills or leakage from motorized watercraft,
- Spills or leakage from restrooms and wastewater management facilities, and
- Erosion and higher turbidity associated with hiking, horseback riding, or camping, particularly if activities are conducted off established trails and areas.

The major water quality problems associated with recreational activities at Lake Del Valle are the contribution of microbial pathogens *Giardia* and *Cryptosporidium*, the release of MTBE from motorized watercraft, and turbidity caused by soil erosion.

Recreational use at Lake Del Valle follows a seasonal pattern, with most visitation between April and September and peak attendance on summer weekends. Recreational use for the 1996 to 1999 period is presented in Table 5-4 as recreation days. A recreation day is defined as 1 user visiting the recreation area during part of a 1-day period.

Table 5-4 Recreational Use at Lake Del Valle

Period	1996	1997	1998	1999
Recreation days	353,700	332,200	283,000	318,900

Source Thrapp pers. comm.

Annual recreation days varied from about 280,000 to 350,000 during this period. Estimates of Lake Del Valle recreation use in 1969 to 1970 were from 260,000 to 570,000 recreation days (DWR 1966), which is similar to use levels in recent years. Original estimates of future use in the millions annually have fallen short. Peak usage occurred in 1988 with 504,595 recreation days. It is not known why usage is much lower than originally estimated, but it could be because some of the planned structures have not been built or are smaller in scale. Data indicates usage has declined. There were about 60,000 fewer recreation days in 1996 than in 1995. The decline was attributed to flooding during the 1995/1996 rainy season and a fire later in the season (DWR 1998).

The EBRPD, which covers all of Alameda and Contra Costa counties, operates recreational services at Lake Del Valle. In July 1970, the year the park opened, the EBRPD assumed operation of Lake Del Valle under a 50-year agreement with the California State Parks and DWR (DWR 1991).

The park was developed in 4 phases, beginning with day use areas and boat launches. Group picnic and camping sites and additional restrooms were added over the next 3 phases. Camping is limited to group campsites and the 1 family campground at the southern end of the lake. The family area has 150 units and 6 restrooms with flush toilets. There are 6 group camping areas at Lake Del Valle. Venados, Hetch Hetchy, and Cedar group campsites are on the eastern side of the lake. Ardilla is on the western side of the lake, and Wild Turkey and Punta Vaca are just south of the lake (Figure 5-3). Venados is one of the largest of the group campsites and occupies a total of 353 acres, all above the minimum lake storage elevation. The Venados area includes parking, beaches, concessions, sanitary facilities, and a 6-lane boat launch, which is a mile south of the campsite.

The 2 main swimming beaches at the lake, East Beach and West Beach (Figure 5-3), are regularly monitored for bacterial contamination. Both beaches are monitored 5 times per week during the peak season from about March to September according to California Department of Health Services (DHS) standards for freshwater beaches. The standards specify acceptable levels of total and fecal coliforms, and *enterococcus* or *E. coli.*, for both single samples and a 5-day geometric mean. The 5-day standard was never exceeded during the report period. The single-day standard was exceeded but only rarely (Burger pers. comm. 2000). The EBRPD posts monitoring results regularly at both beaches.

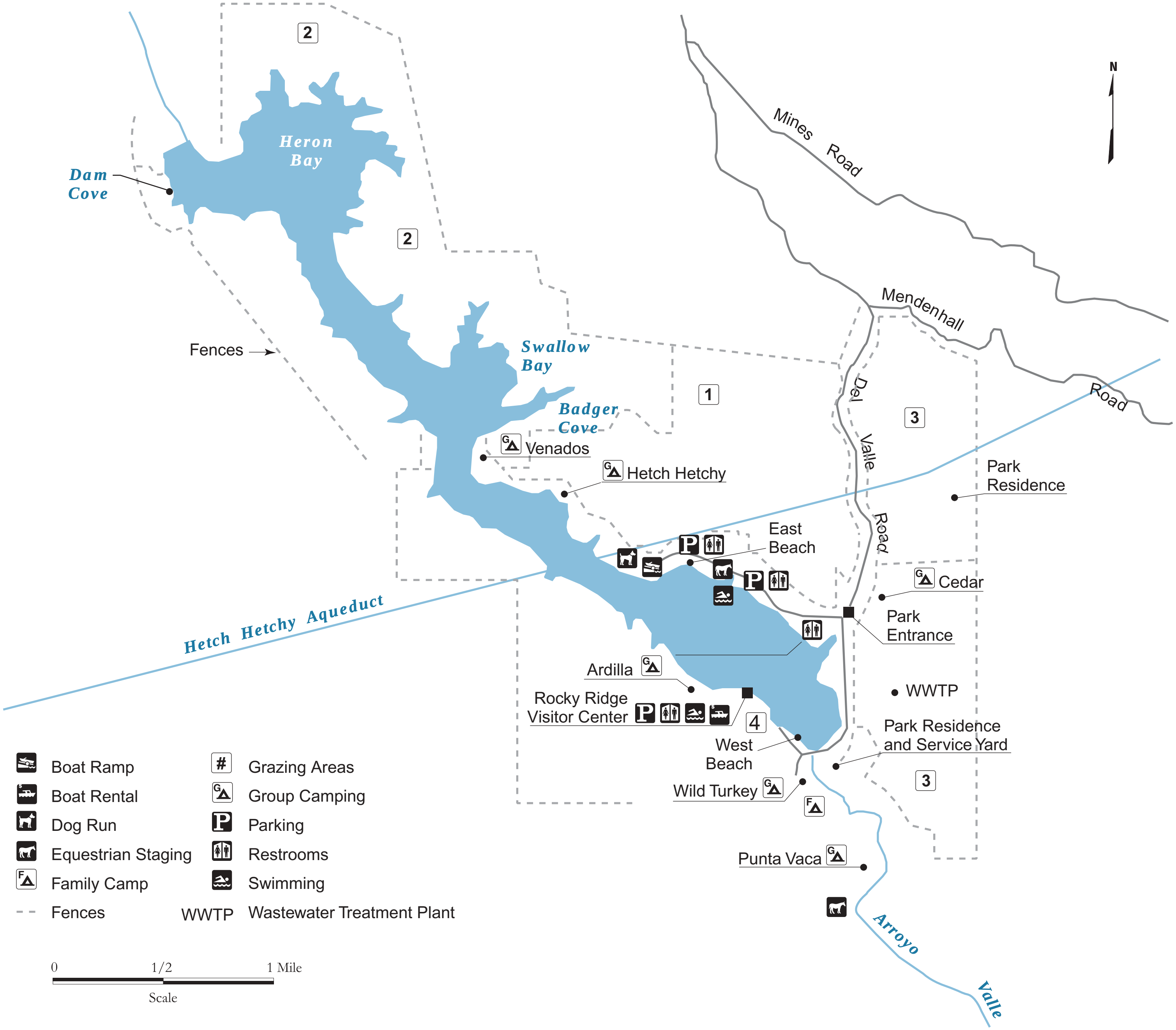


Figure 5-3 Lake Del Valle

One of the main recreation activities at Lake Del Valle is fishing (Gage pers. comm.). The lake is stocked regularly with trout and catfish. There is an extensive trail system around the lake and immediate watershed area. The EBRPD completed the Del Valle East Shore Trail, including a bridge across Arroyo Valle in 1997. This trail connects with several other trails near camping and day use areas. Most of the trail system is concentrated on the eastern side of the lake. Two trails on the southwestern side connect with the Ohlone Trail, which enters the Ohlone Regional Wilderness.

Boating also is a major recreational activity at Lake Del Valle. The primary water quality concern associated with boating is MTBE contamination. Most boating activity occurs from May to October. In 1997, a majority of the boats were powered by 2-stroke outboard engines in the 10 to 75 horsepower range (DWR 1999). The number of private boats launched increased from 1,157 in April to 1,268 in May. The total number of boats remained high at 927 in August and declined to 496 in September. The number of boats using the lake declines by about 50% after Labor Day weekend. As is common in SWP reservoirs, high MTBE concentrations followed heavy boat usage (DWR 1999). A large percentage of the boat usage is resident rental boats. Because rental boats are regularly tuned-up and serviced and their gas tanks removed during filling, which minimizes spills, their higher usage may translate to lower concentrations of MTBE than in lakes with more nonresident boats (DWR 1999).

Swimming is also a significant activity, although it can be dangerous. An EBRPD supervisor at Lake Del Valle reported a drowning that occurred on 3 July 1998 near East Beach. The victim was a nonswimmer who fell from a boat between the boat ramp and the beach.

The availability and quality of recreational activities and services is highly influenced by the lake water levels. The most favorable condition is a lake level at 703 feet. Above the 703-foot level, many areas are inundated and sewage pumping capabilities are lost. Below this level, many services and concessions would close and some parts of the park would need to be closed (DWR 1991). The lake level does fluctuate because of the need to provide flood storage capacity and water supply.

Recreational facilities were continually upgraded during the 1996 to 1999 period, such as renovation of boat launches, new showers, tree plantings, and restroom repair and cleanup. Family campsites and day use facilities were installed in 1998, and renovation of the boat launches was completed in 1999 (DWR 2000a).

5.3.2.2 Wastewater Treatment/Facilities

The major water quality problem associated with wastewater treatment/facilities at Lake Del Valle is the potential contribution of microbial pathogens *Giardia* and *Cryptosporidium* from spills or overflows of raw sewage.

Lake Del Valle park has flush toilets in 21 buildings associated with all major camping areas. Most of the restrooms and related services are in camping areas in the eastern and southwestern areas of the lake. There are also 15 chemical toilets, which EBRPD staff pumped 3 times per week during the summer and once during winter. There were no spills or problems with these toilets from 1996 through 1999.

Treatment Plant Effluent Discharges

There are no known treatment plant effluent discharges at Lake Del Valle or in the watershed area, and no effluents are known to be transported out of the watershed.

Storage, Transport, Treatment, Disposal to Land

There are 6 sewage collection and pumping stations—5 stations out in the park areas and 1 main station. The main station collects all park sewage and pumps it to about 2.5 acres of hypalon-lined wastewater lagoons approximately 8 feet deep on the southeastern side of the lake (Figure 5-3). There is no formal treatment process; treatment of the sewage occurs by natural settling and decomposition. The hypalon lining prevents percolation of the wastewater to soil and groundwater below. Evaporation is used to maintain the water level at acceptable levels. The lagoons occasionally have odors in summer and are drained and inspected as needed (Gigliati pers. comm. 2000).

Some wastewater collection facilities are close to Arroyo Valle, but there was only 1 spill from 1996 through 1999. In 1997, 300 feet of hypalon berm were added around the lagoons, and the graveled road was extended (DWR 1999a). Also, 600 feet of sewer lines and sealed manholes were replaced. Some sewage lines broke during the El Niño storm in 1998, but no sewage was spilled because there was no activity in the park. The El Niño storm raised lagoon water levels, but the berms had been raised 18 inches.

An unknown amount of sewage was released into the Lang Canyon inlet on 24 May 1998. There was a sewage spill from a septic line lift station into the Lang Canyon stream inlet to Lake Del Valle. EBRPD staff reported that the spill had been stopped and booms installed around the area of the spill. The west branch of the reservoir was closed until tests determined the level of contamination. There were no other spills or other problems with any part of the system (Gigliati pers. comm. 2000).

The park is converting to low-flush toilets, upgrading sewer lines, and moving some sewage pumping stations away from Arroyo Valle.

Septic Systems

There were approximately 160 private residences and hunting cabins in the upper portion of the watershed, all served by private septic systems (Brown and Caldwell 1990). Their status is unknown but is thought to be largely unchanged (Gage pers. comm.). There is also a septic tank/leach field system associated with Del Valle Pumping Plant. *Sanitary Survey 1990* reported that this system had no impact on the water quality of Lake Del Valle.

5.3.2.3 Urban Runoff

Because the watershed has little development, urban runoff to the lake is minimal. Urban runoff is primarily from parking lots and roads in the recreation areas. Drainage from the main boat ramp parking area, and probably from the other boat ramps, flows to Lake Del Valle. On the western side of the lake, a 30-acre lawn area is irrigated with water from the park's domestic water system. Runoff from this area into the lake could at times contain fertilizers (Brown and Caldwell 1990). These various sources of runoff can be a minor source of turbidity, pathogens, and nutrients.

The watershed areas are highly erodible during rains (Gage pers. comm. 2000). About 80% of the land in the Lake Del Valle drainage basin is classified as a severe erosion hazard because of its shallow soils and steep slopes. The remaining flat areas around the lake and the San Antonio Valley are less prone to erosion; however, erosion still presents a threat to the development in the area and the use of the recreational amenities. Runoff from surrounding slopes has caused problems adjacent to some existing roads and paved areas. Arroyo Valle has deposited some 20,000 cubic yards of silt in the reservoir since the dam was built (DWR 1996). The sediment load from the creek can cause elevated turbidities in the lake.

Because of these soil and runoff conditions, the Lake Del Valle watershed is extremely sensitive to increased erosion and landslide potential from land use changes such as urbanization and development (DWR 1974). This is addressed in Section 5.3.2.12, Land Use Changes.

5.3.2.4 Animal Populations

Livestock Grazing

Historically, there has been extensive grazing of cattle and sheep in the Lake Del Valle watershed (DWR 1996). The grazing season is dependent on rainfall but usually occurs from late fall through spring. Livestock-grazing on public land is used as a resource management tool to maintain and enhance plant and animal diversity and achieve wildland fire prevention objectives. Although DWR owns the Lake Del Valle SRA land, EBRPD manages it and allows grazing. Revenues from grazing operations are divided between the 2 agencies. (Budzinski pers. comm.).

Two of the largest landowners in the Lake Del Valle watershed, the Naftzger N3 Cattle Company and Patterson Trust, have the largest cattle ranching operations in the watershed. These ranches graze cattle both around the lake and in the upper watershed. The N3 Cattle Company grazes cattle on the southern edge of Lake Del Valle. The Patterson Trust cattle operation is adjacent to the northern edge of the lake, with large holdings around the dam area (Gage pers. comm. 2000). The western side of the lake is not grazed because it is very steep and has poor vegetation. The highest grazing use is typically from November to June, depending on rainfall and grass growth. Historically, cattle have had access to the lake, but not typically from about June through October, when grass is scarce. Some fencing is present, mostly around recreation areas, but much of the grazed land is unfenced to the lake (Chun pers. comm. 2000). Some of the area near lakeshore is fenced, in particular the lower half of the southeastern side of the lake. Much of the northern portion of the lake is unfenced, as is the area around the dam. The approximate locations of fencing around Lake Del Valle are presented in Figure 5-3.

Table 5-5 Total Cattle Grazing Use at Lake Del Valle, 1996 to 1999 (all areas)

	Number of animals								
Grazing Season	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
1995/1996	209	209	209	226	251	251	251	25	1,631
1996/1997	46	226	210	246	212	69	13	0	1,022
1997/1998	187	261	261	290	290	290	290	290	2,159
1998/1999	28	268	200	214	228	228	228	108	1,502
Total	470	964	880	976	981	838	782	423	6,314

Source: Budzinski pers. comm. 2000a.

The density of grazing livestock fluctuates from year to year depending on forage conditions. The livestock may be moved from pasture to pasture over the course of the grazing season. Estimates of the number of cattle grazing in the upper watershed were not available because of the large area and amount of private land involved. Grazing in the recreation area around Lake Del Valle is fairly controlled, and information on grazing allotments was available. Grazing tenants are required to submit stocking plans describing where and how many head of cattle they will graze. Grazing use data from 1996 to 1999 were available for various pasture units around Lake Del Valle from the EBRPD. Grazing activity occurred in 4 areas around the lake primarily from November to June. These areas are numbered 1 through 4 and shown in Figure 5-3. Total grazing use for all 4 areas combined (in numbers of animals) is presented in Table 5-5.

Peak grazing in all areas occurred in the 1997/1998 season with 2,159 animals, followed by 1995/1996 with 1,631 animals. The maximum number of cattle in any one month in any area was 290 in the months February through June 1998. Peak monthly grazing occurred in December, February, and March, with sharp declines noted in November and June. Area 1, which is known as Boat Ramp/Monday, is north of East Beach and east of Hetch Hetchy campsite. This area had the highest overall grazing with a peak annual use of 1,638 animals during 1997/1998, or about 75% of the total grazing at Lake Del Valle that year. Area 1 had an annual average of 1,086 animals. The next highest grazing use was in area 3, which is known as the George/Kennedy Service Yard, with a peak annual use of 560 animals and an annual average of about 283 animals. Approximately 25 to 30 animals grazed in areas 2 and 3 from July to October.

Grazing as a land use practice is being evaluated for all parklands. Additional fencing is being installed to keep cattle from reaching the lake, but only in some areas because of its high cost. When cattle are kept from the lake, it is necessary to create small reservoirs within the fenced areas for water supply. Bullfrogs, then, are able to propagate in these waters and, in turn, prey upon red-legged frogs, an endangered species in the area (Gigliati pers. comm. 2000).

Wild Animal Populations

Because of the watershed's extensive, undeveloped, and rugged nature, its actual number of animals and their condition are unknown. There are reported to be large populations of black-tailed deer, feral goats, wild pig, rabbits, hares, ground squirrels, and other small mammals such as, skunks, gray fox, and coyotes. Their droppings are potential sources of pathogens in the watershed, especially in or near streambeds during rainfall. Contractors have reported concerns about the droppings and their potential effect on water quality (ACWD 2000).

5.3.2.5 Algal Blooms

The occurrence and amount of nuisance algae are controlled by a complex interplay of nutrient loading, species interactions (that is, competition and predation by zooplankton) and physical conditions in the lake, namely, water temperature and light levels. Nutrient availability is controlled by input from source water and by biological regeneration of nitrogen and phosphorus within the lake and from bottom sediments. Assuming there are adequate nutrient levels, temperature and light are commonly the primary determinants for algal blooms observed in spring and fall. A detailed discussion of algae blooms, nutrients, and related reservoir dynamics is presented under Water Quality Summary in Chapter 7, Southern California Reservoirs.

Both historical and recent data collected at Lake Del Valle indicate that MIB and geosmin are being produced and are of concern. MIB is found in the reservoir at higher levels than geosmin, which is opposite the compound levels found in the SBA. Blue-green algae species found include *Synechococcus* sp., which primarily produces MIB but also produces geosmin. Therefore, the source of MIB in Lake Del Valle is uncertain at this point (Janik pers. comm. 2000a). As is common in other

SWP reservoirs, conditions of light, temperature, and nutrients in Lake Del Valle are conducive to algal growth. It is not clear what the relative contribution of the SBA/Delta source waters or the Del Valle watershed is to reservoir algal blooms. Copper sulfate or other chemical controls are not used in Lake Del Valle (Burger pers. comm. 2000). Algal blooms and taste and odor problems are further discussed under Water Quality Summary in Section 5.4.1.7, Taste and Odor.

5.3.2.6 Agricultural Activities

The primary agricultural activity in the watershed is livestock production. Because of the location and type of terrain prevalent in the watershed, other types of agricultural development are extremely limited. In 1974, about 68,400 acres of the watershed were under Williamson Act contracts, which restrict the land to agricultural use for 10-year periods. This has helped to preserve the land in its natural state (DWR 1974).

No pesticides are used in the lake. Roundup is used on terrestrial weeds, and Surflan is used as a pre-emergent herbicide for weeds (Gigliati pers. comm. 2000). There is occasional baiting for ground squirrel control using environmentally benign compounds. An integrated pest management specialist coordinates this and all other applications (Burger pers. comm. 2000). Therefore, this potential contaminant source presents a minimal threat to water quality.

5.3.2.7 Mines

The watershed reportedly had about 35 active and inactive mines, including asbestos and magnesium mines (Figure 5-1). The main road into the park area is named for mines in the vicinity. Past mining activity was for magnesium carbonate deposits in the southeastern part of the watershed near Sweetwater Creek, which receives drainage from the mining area (DWR 1974). Both high magnesium and hardness levels can be associated with this historical mining. In their responses to the sanitary survey questionnaire, SBA contractors did not report any problems or water quality concerns associated with historical mining activities. For further information, refer to discussion of total dissolved solids (TDS) in Section 5.4.1.1.

5.3.2.8 Unauthorized Activity

Underground Storage Tank Leaks

Sanitary Survey Update 1996 reported 1 leaking underground storage tank in Del Valle Park that was removed in 1992. No contamination had reached the lake, and no further action was required. No other problems or incidents were identified or reported during this survey period.

5.3.2.9 Traffic Accidents/Spills

Transportation Corridors

There are several access and feeder roads from the major highways mentioned under Section 5.3.1, South Bay Aqueduct. The main ones are Mines Road, Mt. Hamilton Road, and Patterson Road. The potential appears limited that serious spills of hazardous materials or other contaminants along these roads would reach Lake Del Valle.

History of Accidents/Spills

None of the SBA contractors, DWR field staff, or other agency staff contacted about Lake Del Valle reported any accidents or spills that could affect drinking water supplies during this period.

5.3.2.10 Geologic Hazards

There are several major active faults in the area, as described in Section 5.3.1.8, Geologic Hazards. Five earthquakes of a 4.0 or greater magnitude have occurred in the area since the turn of the century. The strongest was a magnitude 5.5 (DWR 1979).

During a significant seismic event, the SBA would most likely be damaged and water deliveries to and from Lake Valle would cease. There could be catastrophic flooding and damage to area structures if the Del Valle Dam fails. If landslides or earthquakes resulted in significant movement of soil, vegetation, and/or debris into the lake, then water quality in the lake could be seriously affected by turbidity, nutrients, and pathogens or other contaminants associated with land uses that could be flushed into the lake. However, water quality downstream in the SBA would probably not be significantly affected because it is a closed pipeline and utilities would not be taking deliveries.

5.3.2.11 Fires

California Department of Forestry and Fire Protection has primary jurisdiction over wildland fires in the Arroyo Valle area (EBRPD 1998). The EBRPD maintains its own fire department to provide fire and rescue services for regional parklands.

A 1996 fire burned 750 acres and required evacuation of stranded campers from one of the newer campgrounds (DWR 1998). There were no reports of water quality problems associated with the incident.

5.3.2.12 Land Use Changes

The extensive private land ownerships prevalent in the watershed were described under Section 5.1.1, Land Use. There is potential that some of these lands may in the future be subject to development pressures from the growing East Bay region. About 4,000 acres surrounding Lake Del Valle is within the SRA and, because it is held as public land, is less likely to be developed for urban or commercial purposes.

Because of its soil and runoff conditions and high erosion potential, the Lake Del Valle watershed is extremely sensitive to land use changes such as urbanization and development. Even limited land use changes, such as constructing access roads or grading for construction, if not carefully planned, could accelerate soil erosion or landslide problems. Because of this, the watershed is very vulnerable and there is a substantial potential threat to water quality if significant land use changes occur in the basin (DWR 1974).

5.4 WATER QUALITY SUMMARY

In this and the other reservoir water quality sections, comparisons are made between contaminant concentrations in SWP source water and maximum contaminant levels (MCLs) for finished drinking water. Although MCLs are usually applied to finished water, they are useful as conservative indicators of contaminants that are of concern to utilities and that would require removal during the treatment process to meet finished water standards. It follows that if source water concentrations are below MCLs then these contaminants are less likely to be of concern for the finished water supply.

The comparison also serves to focus on 1 or more PCSs associated with the contaminant of concern and allows the development of appropriate recommendations for actions. Although all data examined were below MCLs, land use information suggested the possibility of several water quality concerns, namely, high TDS levels in natural inflows, turbidity, algal blooms, MTBE contamination from recreational watercraft in the reservoir, and pathogen contamination through either recreation or livestock grazing.

5.4.1 WATERSHED

Water quality assessment of Lake Del Valle and its watershed is complicated by reservoir operation practices. SWP water is pumped into the reservoir to maintain a recreational pool during the summer season. Water is released in the fall to reserve flood control capacity. Natural inflow from the watershed is impounded in Lake Del Valle during winter months. From 1996 through 1999, natural inflow constituted the majority of inflows into the reservoir (Table 5-3). Therefore**,** in many cases**,** water quality samples collected at Lake Del Valle may be more representative of natural inflow than of SWP inflow. To examine water quality between Lake Del Valle and the SBA, water quality data from Lake Del Valle was compared to water quality data from Banks Pumping Plant, considered to be representative of SBA's water quality above Lake Del Valle.

Water quality data from Lake Del Valle from 1996 through 1999 are presented in Table 5-6. All parameters were below applicable drinking water levels. Minor elements that were detected at low concentrations in 1 or more samples included arsenic, barium, boron, chromium, copper, iron, manganese, and zinc. Several elements had many samples with values less than the detection limit. Values less than the detection limit were included in statistical calculations as the detection limit; however, statistics were not calculated for elements with 2 or fewer detections. Results for minor elements in Table 5-6 represent dissolved concentrations. Because MCLs are based on total metal concentrations, direct comparisons between drinking water MCLs were not made.

Table 5-6 Lake Del Valle, Sep 1996 to Nov 1999

Parameter (mg/L)	Mean	Median	Low	High	Percentile 10-90%	Detection Limit	# of Detects/ Samples
Minerals							
Calcium	32	32	27.0	39	28-38	1	17/17
Chloride	10	10	6	16	6-11	1	18/18
Total Dissolved Solids	218	215	169	275	171-270	1	17/17
Hardness (as $CaCO_3$)	160	157	124	204	125-204	1	18/18
Alkalinity (as $CaCO_3$)	148	152	113	182	117-154	1	17/17
Conductivity (uS/cm)	374	379	285	456	294-453	1	18/18
Magnesium	20	20	14	27	14-26	1	17/17
Sulfate	35	35	19	50	25-38	1	18/18
Turbidity (NTU)	17	3	<1	65	1-31	1	17/18
Minor Elements							
Arsenic	0.002	0.002	<0.001	0.003	<0.001-0.002	0.001	14/18
Barium	0.1	0.073	0.05	0.085	0.05-0.08	0.05	18/18
Boron	0.1	0.1	<0.1	0.2	0.1-0.2	0.1	16/17
Chromium	0.006	0.005	<0.005	0.013	<0.005-0.01	0.005	8/18
Copper	0.003	0.002	<0.001	0.005	<0.001-0.005	0.005	11/18
Iron	0.005	0.005	<0.005	0.009	<0.005-0.006	0.005	3/17
Manganese	NC	NC	<0.005	0.028	NC	0.005	2/17
Zinc	0.119	0.076	0.024	0.437	0.03-0.25	0.05	17/18
Nutrients							
Total Kjeldahl Nitrogen (as N)	0.4	0.4	0.2	0.6	0.3-0.5	0.1	25/25
Nitrate (as NO3)	0.8	0.3	<0.1	2.2	0.1-1.4	0.1	13/17
Nitrate+Nitrite (as N)	0.08	0.01	<0.01	0.47	0.01-0.33	0.01	27/50
Total Phosphorus	0.02	0.02	<0.01	0.08	0.01-0.05	0.01	40/50
OrthoPhosphate	0.01	0.01	<0.01	0.03	0.01-0.01	0.01	7/50
Misc.							
Bromide	0.03	0.02	0.01	0.05	0.02-0.04	0.01	12/12
Total Organic Carbon	NC	NC	3.3	3.4	NC	0.1	2/2
pH (pH unit)	8.1	8.1	7.8	8.5	7.9-8.3	0.1	18/18

Barium and zinc were the only minor elements that were detected at higher concentrations in Lake Del Valle than at Banks Pumping Plant (Table 5-7). Samples collected at the Del Valle outlet have historically had the highest zinc concentrations of all samples collected in the SWP (DWR 2000). Zinc ranged from 0.024 to 0.437 mg/L and averaged 0.119 mg/L. Even though these were dissolved values, the highest zinc concentration detected was still an order of magnitude lower than secondary MCLs. Because of the lack of data, organic compounds in Lake Del Valle were not examined.

Table 5-7 Banks Pumping Plant, Jan 1996 to Dec 1999

Parameter (mg/L)	Mean	Median	Low	High	Percentile 10-90%	Detection Limit	Number of Detects/ Samples
Minerals							
Calcium	17	16	9.0	25	13-22	1	51/51
Chloride	48	40	12	151	19-94	1	52/52
Total Dissolved Solids	204	182	85	399	123-303	1	51/51
Hardness (as $CaCO^3$)	82	82	38	121	60-113	1	52/52
Alkalinity	63	62	33	95	48-76	1	51/51
Conductivity (µmohs/cm)	365	344	148	725	215-535	1	52/52
Magnesium	10	9	4	16	7-14	1	51/51
Sulfate	34	30	12	77	16-55	1	52/52
Turbidity (NTU)	11	8	<1	68	<1-26	1	46/52
Minor Elements							
Arsenic	0.002	0.002	0.001	0.003	0.001-0.002	0.001	47/47
Boron	0.2	0.1	<0.1	1.2	0.1-0.3	0.1	42/51
Barium	NC	NC	<0.05	<0.05	NC	0.05	0/47
Chromium	0.005	0.005	<0.005	0.006	0.005-0.005	0.005	4/47
Copper	0.007	0.004	<0.001	0.095	0.002-0.009	0.005	30/47
Iron	0.016	0.01	<0.005	0.083	0.005-0.03	0.005	39/47
Manganese	0.016	0.015	<0.005	0.034	0.005-0.03	0.005	40/47
Selenium	0.001	0.001	<0.05	0.002	0.001-0.001	0.05	3/47
Zinc	NC	NC	<0.01	0.02	NC	0.01	2/47
Nutrients							
Total Kjeldahl Nitrogen (as N)	0.5	0.4	0.2	0.9	0.3-0.7	0.1	26/26
Nitrate (as NO3)	3.1	2.8	0.4	8	1.2-5.5	0.1	51/51
Nitrate+Nitrite (as N)	0.71	0.67	0.09	1.8	0.28-1.3	0.01	51/51
OrthoPhosphate	0.08	0.07	0.02	0.13	0.05-0.13	0.01	51/51
Total Phosphorus	0.13	0.12	0.07	0.22	0.08-0.18	0.01	51/51
Misc.							
Total Organic Carbon	3.7	3.4	2.3	6.7	2.7-5.1	0.1	44/44
Bromide	0.15	0.13	0.04	0.52	0.06-.29	0.01	51/51
pH (pH unit)	7.4	7.3	6.6	8.1	7-8	0.1	52/52

Source: DWR O&M Division database
Notes: Totel Kjeldahl Nitrogen data from Oct 96 to Mar 98 only
Statistics include values less than detection limit, if applicable
NC= not calculated, statistical values were not calculated for parameters with 2 or less detections

5.4.1.1 Total Dissolved Solids

Highly erodible soils in the Del Valle watershed contribute dissolved solids to the natural runoff entering the reservoir. TDS and conductivity were similar in the Del Valle and Banks samples (Tables 5-6 and 5-7). Because more samples were collected at Banks than at Lake Del Valle, it is unknown whether the greater TDS variation observed at Banks is due to sampling frequency or greater variation in Delta waters. From 1996 through 1999, samples collected from Lake Del Valle had higher concentrations of calcium and magnesium than did the samples collected at Banks. Calcium in Lake Del Valle ranged from 27 to 39 mg/L and averaged 32 mg/L. While these values are far below the secondary MCL of 250 mg/L, they were elevated in comparison to samples collected at Banks Pumping Plant, which had a mean of 17 and ranged from 9 to 25 mg/L. Magnesium followed a similar pattern, ranging from 14 to 27 mg/L in Lake Del Valle and only 4 to 16 mg/L at Banks Pumping Plant.

With respect to hardness, runoff into Lake Del Valle from 1996 through 1999 had a large impact on water quality. Hardness measurements at Lake Del Valle reflected the lake's higher concentrations of calcium and magnesium. The maximum hardness detected at Lake Del Valle was 204 mg/L as $CaCO_3$ compared to 121 mg/L as $CaCO_3$ at Banks Pumping Plant. As discussed in Section 5.1.4, Hydrology, there are magnesium mines in the watershed that, in conjunction with the large natural inflows into the lake, could be related to the high hardness and alkalinity levels.

Lake Del Valle had much lower chloride concentrations than did Banks Pumping Plant samples. Chloride ranged from 6 to 16 mg/L at Lake Del Valle and from 12 to 151 mg/L at Banks. Natural runoff from the Lake Del Valle watershed appears to have a substantial diluting effect on chloride concentrations in the SBA.

5.4.1.2 Turbidity

Erodible soils in the watershed increase turbidity. Recreational activities at the reservoir, algal blooms, and grazing activities in the watershed contribute to erosion and increased turbidity. Turbidity in Lake Del Valle ranged from nondetect to 65 NTUs with a mean of 17 NTUs (Table 5-6). These values were similar to values observed at Banks Pumping Plant (Table 5-7). Turbidity at Banks Pumping Plant ranged from nondetect to 68 NTU and averaged 11 NTUs. At both locations, 90% of the samples collected were below 35 NTUs. The maximum value of 65 NTUs at Lake Del Valle was observed in February 1998 when Arroyo Valle flows were unusually high because of El Niño storms.

5.4.1.3 Total Organic Carbon (DBP Precursors) and Alkalinity

Organic carbon and bromide in source water react with disinfectants in the treatment process to produce trihalomethanes, haloacetic acids, and bromate. Very little total organic carbon (TOC) data were collected at Lake Del Valle from 1996 through 1999 (Table 5-6). Although 2 samples collected in October and November 1999 indicated that TOC levels in Lake Del Valle were similar to levels observed at Banks Pumping Plant, there were not enough data to draw any conclusions on which water source had the most influence on TOC.

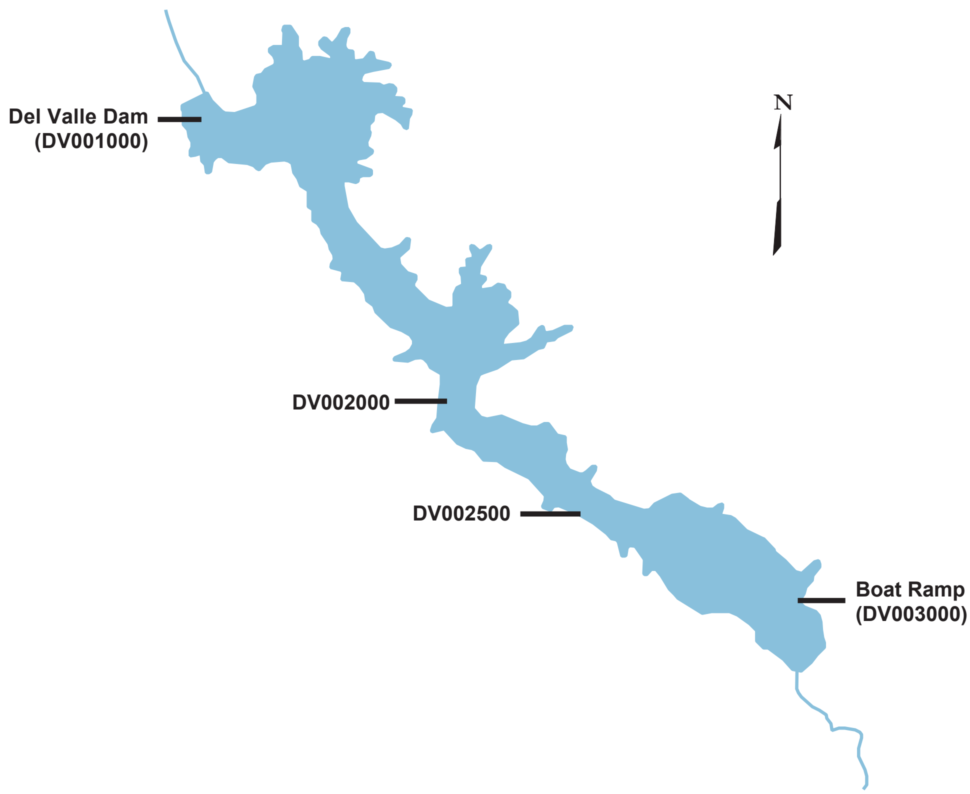
Alkalinity was higher in Lake Del Valle than at Banks Pumping Plant. Alkalinity in Lake Del Valle ranged from 113 to 182 mg/L as $CaCO_3$. SBA water ranged from 48 to 76 mg/L. The D/DBP Rule mandates higher TOC removal for source waters with low alkalinity. Thus, the high alkalinity water entering the SWP from Lake Del Valle probably reduces treatment costs.

Bromide levels observed in Lake Del Valle were much lower than those observed at Banks Pumping Plant (Tables 5-6 and 5-7). Twelve bromide samples were collected at Lake Del Valle from 1996 through 1999. Bromide ranged from 0.01 to 0.05 mg/L and averaged 0.03 mg/L. In contrast, bromide concentrations at Banks Pumping Plant ranged from 0.014 to 0.52 mg/L and averaged 0.15 mg/L, 5 times higher than the average bromide concentration in Lake Del Valle. Although fewer samples were collected at Lake Del Valle, it is reasonable to assume that bromide water quality in the SBA reflects the seawater contributions of Delta water at Banks. Lake Del Valle dilutes the impact of SBA's Delta water. A detailed discussion of bromide levels in SBA source water is provided under Section 5.4.2.2, Total Organic Carbon (DBP Precursors) and Alkalinity, and in the Banks Pumping Plant section of Chapter 4.

5.4.1.4 MTBE

MTBE was sampled at 4 locations in Lake Del Valle in 1997 and 1998 (Figure 5-4). Surface samples were collected at all 4 locations. In 1997, additional depths were sampled near the dam at DV001000. Sampling depth was dependent on the temperature regime in the lake. The mid-depth samples were collected between 4 meters and 12 meters deep; and the lower depth samples between 8 meters and 14 meters. During most of 1997, mid-depth samples were near the bottom of the epilimnion

Figure 5-4 MTBE Sampling Sites on Lake Del Valle, 1997 to 1998



and deep-water samples were below the thermocline.

Data on the temperature regime of Lake Del Valle were available for 1997. The depth to the thermocline was 5 meters at the beginning of the sampling period in April. The thermocline deepened to 10 meters by mid-June. The thermocline began to weaken in late September 1997, and the lake was isothermal by early December 1997.

MTBE concentrations in Lake Del Valle were lower than MTBE concentrations in the 4 Southern California SWP reservoirs. For example, at Lake Perris, DWR detected surface concentrations of MTBE as high as 32 µg/L, while at Castaic, Pyramid, and Silverwood lakes, DWR measured surface MTBE concentrations as high as 24, 27, and 13µg/L, respectively. At Lake Del Valle, surface MTBE concentrations ranged from 1.4 to 10.2 µg/L (Figure 5-5 and Table 5-8). All samples were below the 13 µg/L primary MCL. However, many surface samples exceeded the secondary MCL of 5µg/L. MCLs are only valid for finished drinking water, and some of the MTBE is removed during the treatment process.

Figure 5-5 Surface MTBE Concentrations at Lake Del Valle, 1997 to 1998

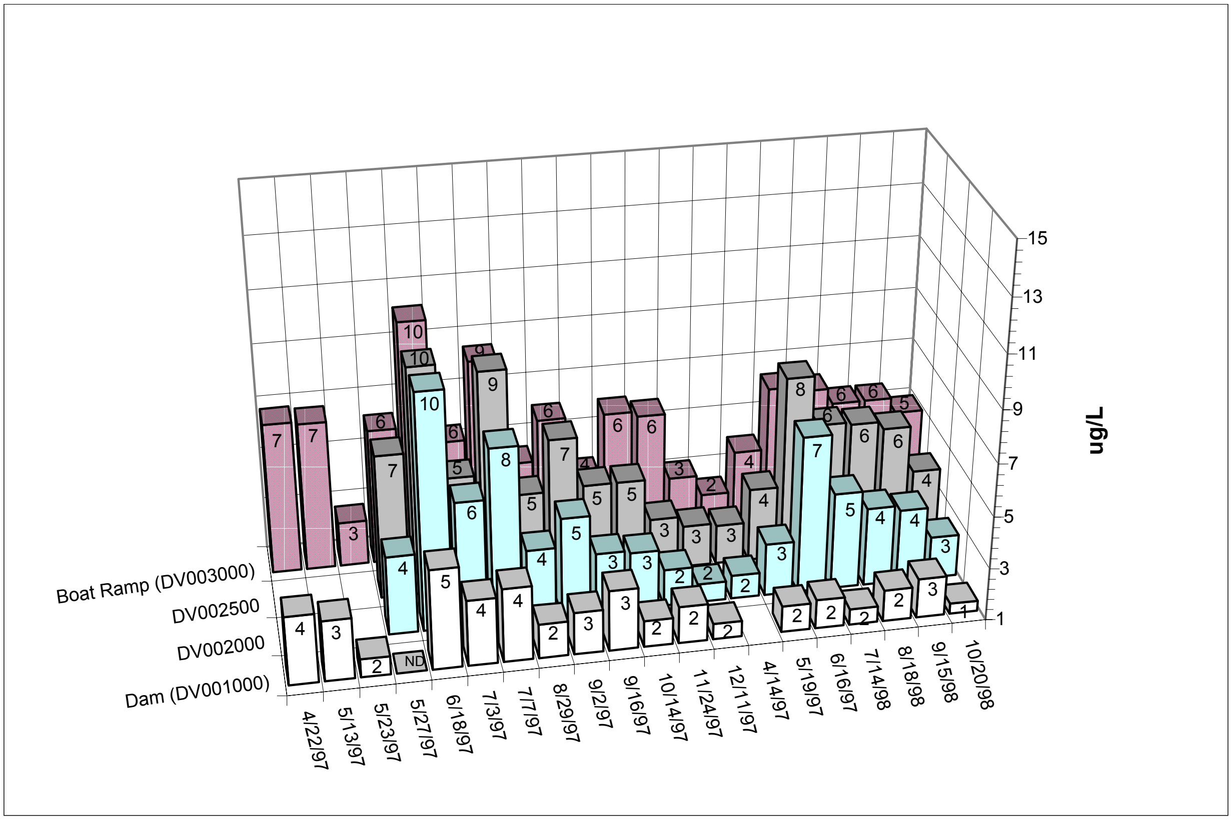


Table 5-8 Surface MTBE Concentrations (μg/L) in Lake Del Valle, 1997 to 1998

Station	Min	Max	Mean
Boat Ramp (DV003000)	2.4	10.2	5.7
DV002500	2.5	9.7	5.3
DV002000	1.7	10.0	4.2
Dam (DV001000)	1.4	4.8	2.6

Note: Statistics do not include values less than the reporting limit.

MTBE concentrations in Lake Del Valle varied both spatially and seasonally. MTBE levels were higher near the boat ramp than at the dam. Samples collected at DV003000, near the boat ramp, had an average MTBE concentration of 5.7 μg/L. This value decreased to 5.3 μg/L at DV002500, 4.2 μg/L at DV002000, and 2.6 μg/L at DV001000 (Table 5-8).

MTBE concentrations were highest in spring and summer when most watercraft recreation occurs. MTBE levels were highest from May through July in 1997 and from May through September in 1998 (Figure 5-5). Surface concentrations at the dam were less variable, ranging between nondetect and 4.8 μg/L.

In 1997, to examine the impacts of peak motorized watercraft activity, MTBE concentrations were examined before and after major holidays. Samples were collected before and after Memorial Day, 4th of July, and Labor Day holiday weekends. As shown in Table 5-9, the increase of MTBE levels over holiday weekends was greatest at the boat ramp and decreased with distance. These findings are

.

Table 5-9 Increase in MTBE Concentrations at Lake Del Valle Over Major Holiday Weekends (µg/L)

Sampling stations	Memorial Day		4th of July		Labor Day	
	23 May 1997	27 May 1997	13 Jul 1997	7 Jul 1997	29 Aug 1997	2 Sep 1997
Boat Ramp (DV003000)	2.7	6.2	5.5	8.5	4.4	6
DV002500	NS	NS	5.4	9.3	4.5	6.5
DV002000	NS	NS	6	8	4	5
Dam (DV001000)	1.7	<1	3.5	3.8	2.3	2.6

Weekends

Data provided by DWR O&M, 13 Dec 2000

consistent with Southern California reservoir results discussed in Chapter 7. At the boat ramp, MTBE concentrations increased by almost 4 µg/L over the Memorial Day weekend, 3 µg/L over the 4th of July weekend, and nearly 2 µg/L over the Labor Day weekend. At station DV002500, MTBE increased by 4 µg/L over the 4th of July weekend, and 2 µg/L over the Labor Day weekend. At station DV002000, approximately 1.7 miles from the boat ramp, the increases were less dramatic. MTBE at station DV002000 increased by 2 µg/L over the July 4th weekend and 1 µg/L over the Labor Day weekend. At the dam (DV001000), no appreciable change in MTBE concentration was observed over the holiday weekends.

5.4.1.5 Pathogens

See Chapter 12 for a discussion of pathogen issues.

5.4.1.6. Nutrients

Nutrients such as nitrogen and phosphorus are important water quality parameters because of both their direct effects on water potability and their influence on algal populations in lakes. Because of high nitrogen and phosphorus loading from the SWP, direct runoff and precipitation, most SWP reservoirs are nutrient-rich and would be classified as eutrophic with respect to algal productivity. Nutrient levels indirectly affect water quality in these lakes by stimulating growth of nuisance algae, which are associated with release of taste and odor compounds such as geosmin and MIB. High concentrations of certain diatom species can also affect treatment plant operations by clogging filters and interfering with coagulation and flocculation treatments. Eutrophic lakes often experience periods of anoxia in bottom waters because of microbial respiration fueled by periodic die-off of algae.

The occurrence and amount of nuisance algae are controlled by a complex interplay of nutrient loading, species interactions (competition and predation by zooplankton) and physical conditions in the lake, namely temperature and light levels. Nutrient availability is controlled by inputs from source waters and by biological regeneration of nitrogen and phosphorus within the lake and from bottom sediments.

During spring, reservoirs typically have low turbidity, good light penetration and no temperature stratification (Coburn pers. comm. 2001). As spring progresses, water temperatures rise and stimulate algal growth resulting in a bloom. Decreasing water clarity because of the algal bloom coupled with increasing solar inputs (that is, longer days, higher sun angle) results in thermal stratification of the lake. The warmer (that is, less dense) upper portion of the water column is separated by a thermocline (region of maximum temperature change with depth) from the colder (that is, more dense) lower portion of the water column. The upper portion of the lake is referred to as the epilimnion and is typically well mixed, and light levels are sufficient for algae to grow, thus oxygen levels are high. The portion of the lake below the thermocline is referred to as the hypolimnion and is usually too dark for algal growth. Microbial respiration (that is, consumption of oxygen) fueled by organic materials that sink from the epilimnion (dead algae) and by algal respiration (sinking live algae) can lead to low oxygen levels (hypoxia) or a total depletion of dissolved oxygen (anoxia) in the hypolimnion.

By mid to late summer, nutrients have been depleted by algal growth in the epilimnion, and algal biomass declines. Nutrients released by microbial decomposition in the hypolimnion cannot be resupplied to the epilimnion while a strong thermocline persists. Thermal stratification typically persists into fall when surface waters cool and become more dense (they sink) resulting in a lake mixing or turnover event. Wind can also contribute to lake mixing. When the lakes mix, turbidity decreases and nutrients that have accumulated in hypolimnetic waters reach shallower depths in the lakes with sufficient light for algal growth, leading to a fall bloom. Spring and fall algal blooms are commonly observed in SWP reservoirs and in temperate lakes throughout the world; however, the specific timing and magnitude of algal blooms vary from year to year and from lake to lake and are difficult to predict.

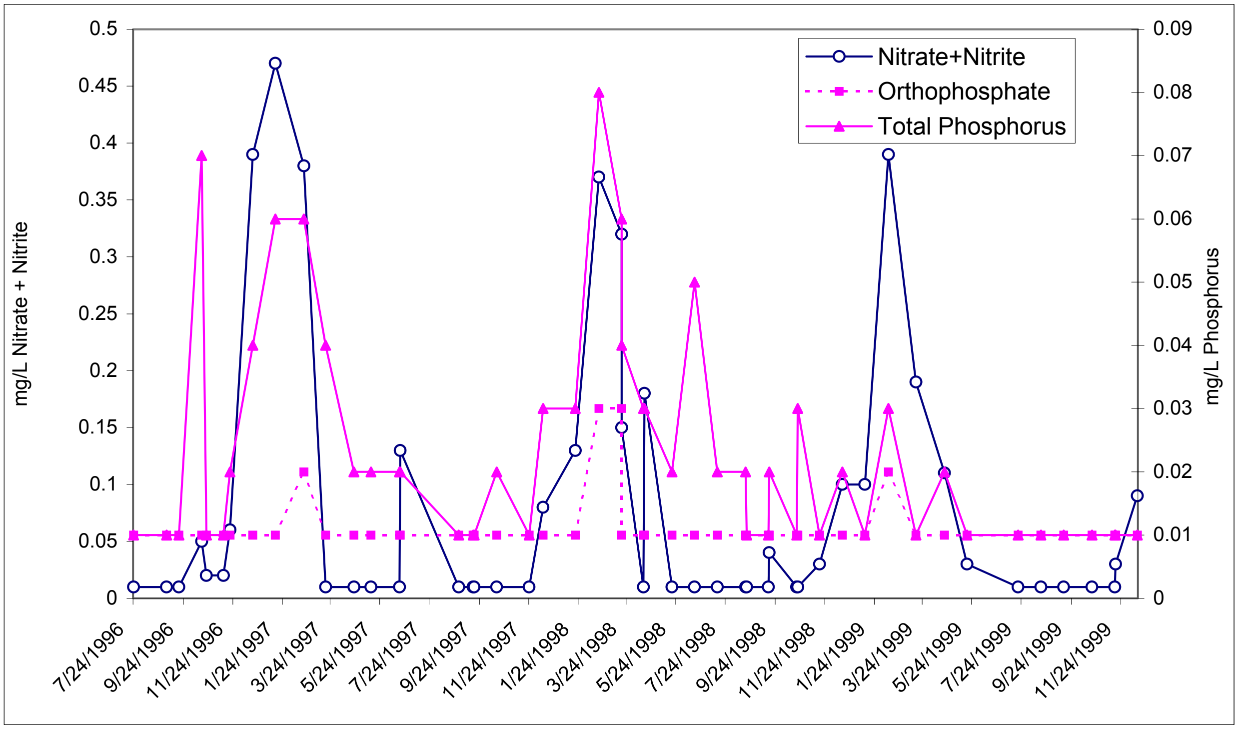
A more detailed analysis of algal/nutrient dynamics and factors controlling the abundance of nuisance algae in each of the individual SWP reservoirs is beyond the scope of this report. Therefore, this *Sanitary Survey Update* will describe nutrient conditions and noteworthy instances of algal blooms or nuisance algae in each of the SWP reservoirs. This report does not attempt to determine the causes of algal population dynamics or establish a connection between specific algal blooms and nutrient, light or temperature conditions in the lakes.

Nutrient levels were generally lower at Lake Del Valle than at Banks Pumping Plant. At Lake Del Valle, total phosphorus ranged from 0.01 to 0.08 mg/L and averaged 0.02 mg/L (Table 5-6). At Banks Pumping Plant, total phosphorus ranged from 0.07 to 0.22 mg/L (Table 5-7). With an average concentration of 0.13 mg/L, the total phosphorous concentrations at Banks Pumping Plant were an order of magnitude higher than those for Lake Del Valle. Orthophosphate showed similar differences, with values ranging from 0.01 to 0.03 mg/L at Del Valle and 0.02 to 0.13 mg/L at Banks Pumping Plant.

Total Kjeldahl Nitrogen averaged 0.5 mg/L at Banks and 0.4 mg/L at Lake Del Valle. Differences between the 2 sites were greater for nitrate. Nitrite concentration in surface waters is generally low; therefore, nitrate+nitrite values were treated as nitrate. Nitrate (as N) averaged 0.71 mg/L at Banks and 0.08 mg/L at Lake Del Valle. Nitrate (as NO_3) averaged 3.1 mg/L at Banks and only 0.8 mg/L at Lake Del Valle. All nitrate samples were well below their respective finished water MCLs.

Nitrogen and phosphorus levels in Lake Del Valle exhibited seasonal variation (Figure 5-6). Levels typically reached a maximum in the winter months and declined sharply in the spring when nutrients were depleted because of algal productivity. Lower nutrient levels in the spring/summer suggest high nutrient utilization and likely serves to limit algal growth. Surface nitrogen and phosphorus concentrations increase in the fall when lake mixing resuspends nutrients sequestered in the hypolimnion and algal growth is limited because of low temperatures and sunlight. It is important to note that nutrient samples were collected at the reservoir's outlet and may not provide an accurate representation of deeper layers of the lake.

Figure 5-6 Seasonal Variation in Nutrient Concentrations in Lake Del Valle, 1996 to 1999



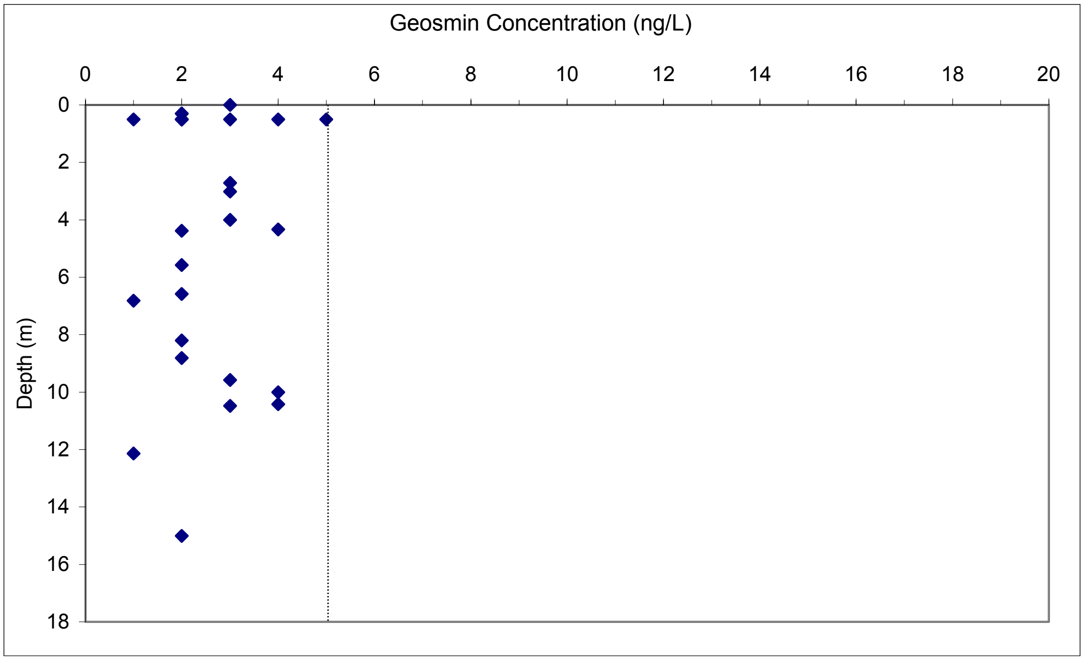
5.4.1.7 Taste and Odor

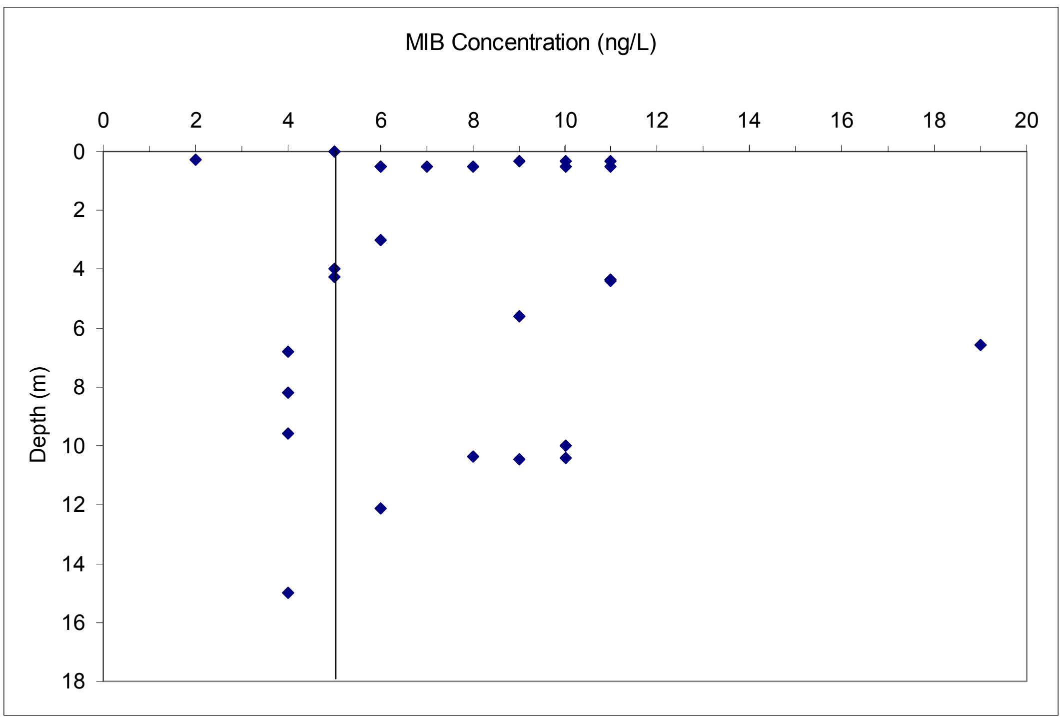
There are several factors that influence the production of malodorant compounds in surface waters. Ambient light conditions, available nutrients, and water temperature are among the most important factors affecting algal production in surface waters. Certain algal species produce high concentrations of malodorant compounds such as MIB and geosmin. MIB and geosmin have extremely low odor detection thresholds; many people can detect concentrations as low as 5-10 ng/L.

Contractors that treat SBA water reported that taste and odor problems in source water occur mainly in spring, summer, and fall. Contractors also noted higher concentrations of taste and odor contaminants in source water following treatment of the SBA with copper sulfate ($CuSO_4$). Copper sulfate treatment kills much of the algae in the aqueduct, which can lead to algal cells lysing and releasing taste and odor contaminants.

Both MIB and geosmin were detected at all depths sampled in Lake Del Valle (Figure 5-7), and there was no apparent pattern associated with depth. The majority of geosmin detections occurred below the 5 to 10 ng/L taste and odor threshold, while the majority of MIB detections occurred above this range. Geosmin concentrations ranged from 1 to 5 ng/L with a mean of 2 ng/L while MIB concentrations ranged from 2 to 19 ng/L and averaged 8 ng/L. The highest MIB values were recorded in October 1998 and October 1999.

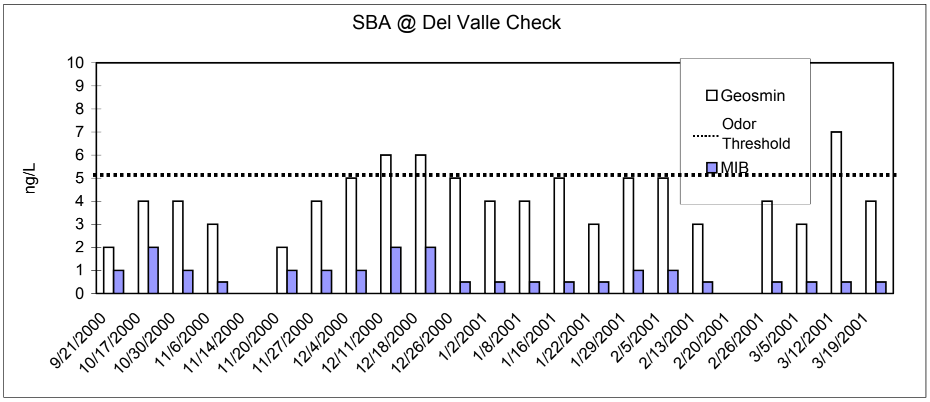
Figure 5-7 Geosmin and MIB Concentrations at Lake Del Valle Dam by Depth

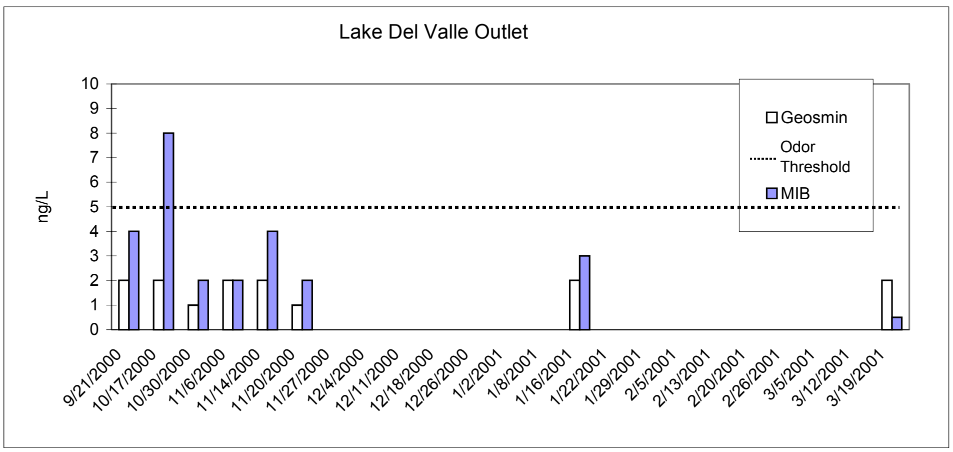


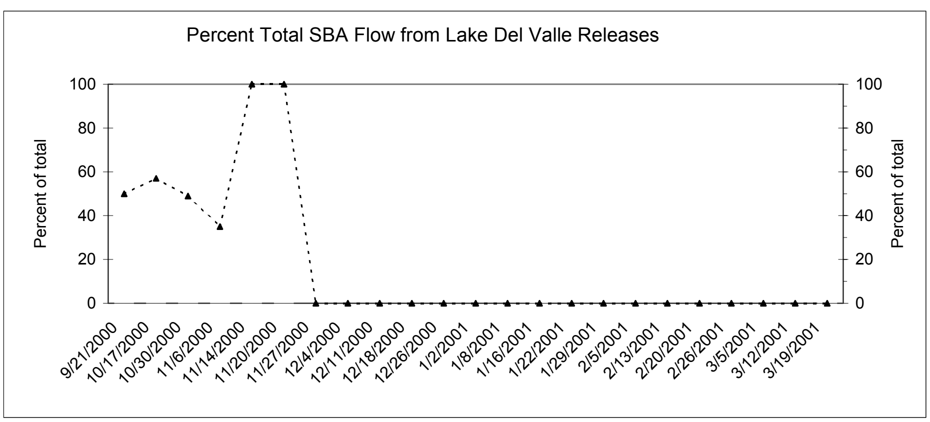


It is difficult to determine the source of MIB and geosmin in Lake Del Valle. The compounds could have been present in SBA inflows, or they could have formed within the reservoir. However, recent DWR data suggest that geosmin may have a larger influence on taste and odor problems when the origin of the source water is the SBA/Delta. MIB may affect taste and odor when the origin of the source water is Lake Del Valle (Figure 5-7). Figure 5-8 shows the relative concentrations of geosmin and MIB in the SBA at the Del Valle check (Check 7 at mile 16.31, above Lake Del Valle) and the Lake Del Valle outlet from weekly samples collected September 2000 through March 2001. Also shown is Lake Del Valle's percent contribution by volume to the total SBA flow. On 1 occasion during Lake Del Valle releases, MIB concentrations were above the taste and odor threshold. Following the cessation of Lake Del Valle releases, measured concentrations of geosmin in Delta water were often at or above the taste and odor threshold. Although this suggests that geosmin problems primarily originate from Delta water and MIB problems from Lake Del Valle water, no samples were collected from Lake Del Valle when water was not released. Therefore, it is unknown whether the relative dominance of MIB and geosmin in Lake Del Valle water would have changed as the season progressed. Several more seasons of data would be required to confirm these observations.

Figure 5-8 MIB and Geosmin Concentrations at the Lake Del Valle Check and the Lake Del Valle Outlet and Percent Contributions of Lake Del Valle Outflow to Total South Bay Aqueduct Volume, Sep 2000 to Mar 2001







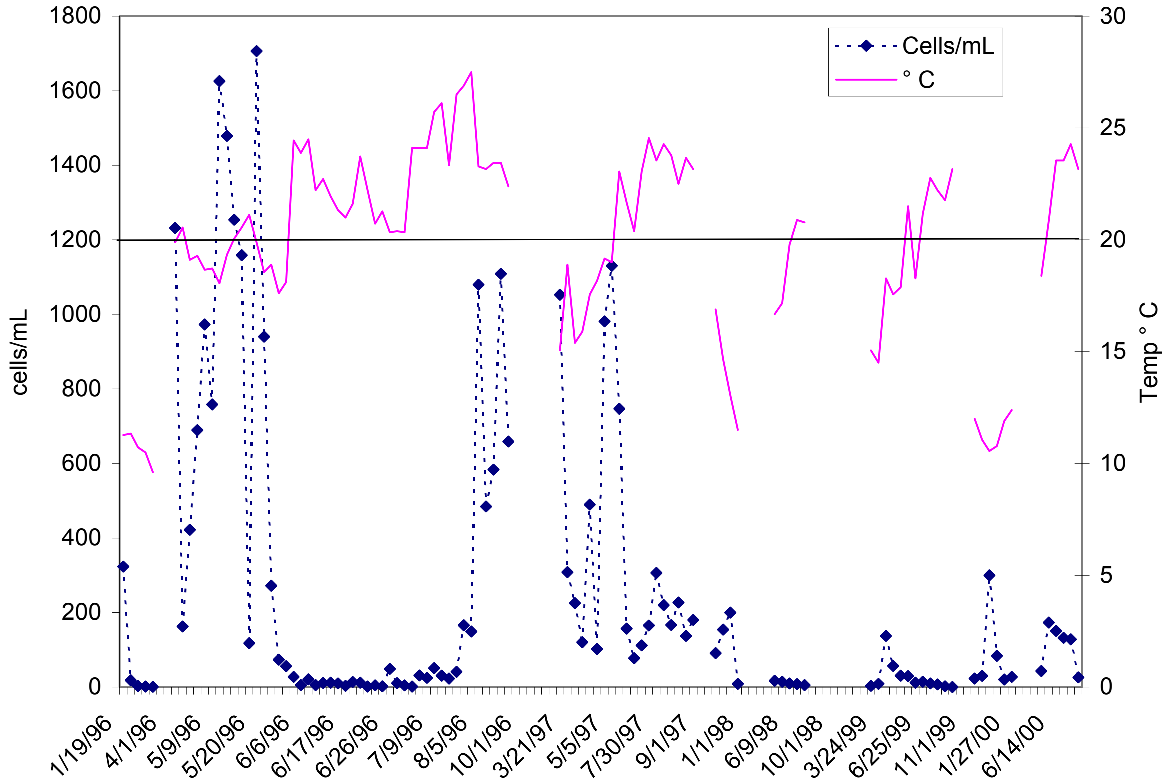
5.4.2 WATER SUPPLY SYSTEM

The 3 SBA contractors evaluated included ACWD, Zone 7 Water Agency, and SCVWD. These agencies reported no Title 22 MCL violations (Brewster pers. comm. 2001, Chun pers. comm. 2001, Marchand pers. comm. 2001, and O'Brien pers. comm. 2001). Title 22 parameter categories for primary MCLs include inorganic chemicals (trace metals, nitrate/nitrite, asbestos), radioactivity, total trihalomethanes (TTHMs), and organic chemicals. Secondary MCLs include—but are not limited to—iron, manganese, odor, turbidity, TDS, conductivity, chloride, and sulfate. Because contractors had no MCL violations, water quality issues within the water supply system focused on what the SBA contractors cited as water quality challenges: taste and odor, DBPs, and DBP precursors TOC and bromide.

5.4.2.1 Taste and Odor

The background and current status of taste and odor problems in the SBA and Lake Del Valle are discussed in sections 5.3.1.5 and 5.3.2.5, respectively. Of the SBA contractors, ACWD conducted the most complete algal studies at its WTP2. In months when algal samples were collected, they were generally collected weekly or biweekly. In both 1996 and 1997, increased algal numbers were observed in the month of May (1996 and 1997) or March through May (1997) (Figure 5-9). Similar peaks were not observed in 1998 or 1999. No samples were collected in March or April 1996, so it is not known whether the increase in algal numbers observed in May 1996 actually began earlier as was observed in 1997 data. Algal blooms were observed in August 1996; a similar bloom was not observed 1997 through 1999 (no data available for 2000).

Figure 5-9 Algal Count (cells/mL) and Temperature of ACWD WTP2 Influent



Algal growth and succession are based on a number of factors. As shown in Figure 5-9, temperature alone could not explain the presence or absence of algal blooms. An examination of algal species by month shows that with the exception of February, *Melosira* spp. was the dominant algal species in influent water (Figure 5-10). However, from 1996 through 2000, extensive algal sampling was only conducted May through August (Table 5-10); therefore, species composition in other months may be inaccurate. Interestingly, geosmin- and MIB-producing algae detected by DWR in either the SBA or Lake Del Valle (for example, *Oscillatoria* sp. or *Synechococcus* sp.) were not detected in ACWD algal samples.

Figure 5-10 Proportion of Algal Species Found in ACWD WTP2 Influent (Averaged by Month from Jan 1996 to Jul 2000)

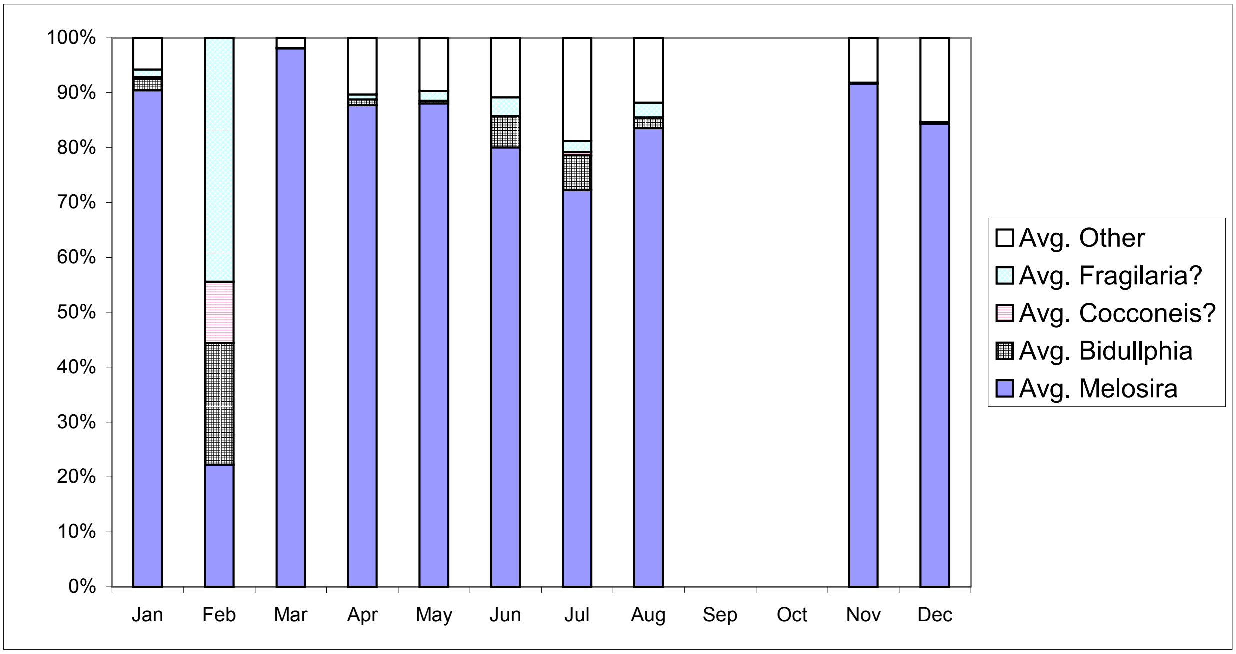


Table 5-10 Number of ACWD WTP2 Influent Samples Counted for Algae by Month, Jan 1996 to Jul 2000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Algal Counts	6	3	4	7	24	25	14	12	0	0	2	4

With respect to actual taste and odor constituents, most geosmin and MIB analyses have been conducted by DWR's O&M (see Section 5.4.1.7). In May 2000, O&M and the SBA contractors agreed to increase MIB and geosmin monitoring in the SBA and Lake Del Valle in fall when blue-green algae become abundant (Janik pers. comm. 2000). The SCVWD also began analyzing for both of these constituents in 2001 (Brewster pers. comm. 2001a).

In summer 2000, following implementation of the new copper sulfate treatment procedure described in Section 5.3.1.5, Algal Blooms, all SBA treatment plants evaluated in this report noted improvement of taste and odor problems (Brewster pers. comm. 2001; Deol pers. comm. 2001; Hidas pers. comm. 2001). Comparisons between algal numbers or taste and odor constituents at Banks Pumping Plant relative to the SBA will have to be examined over several summer bloom seasons to determine the efficacy of this treatment strategy.

5.4.2.2 Total Organic Carbon (DBP Precursors) and Alkalinity

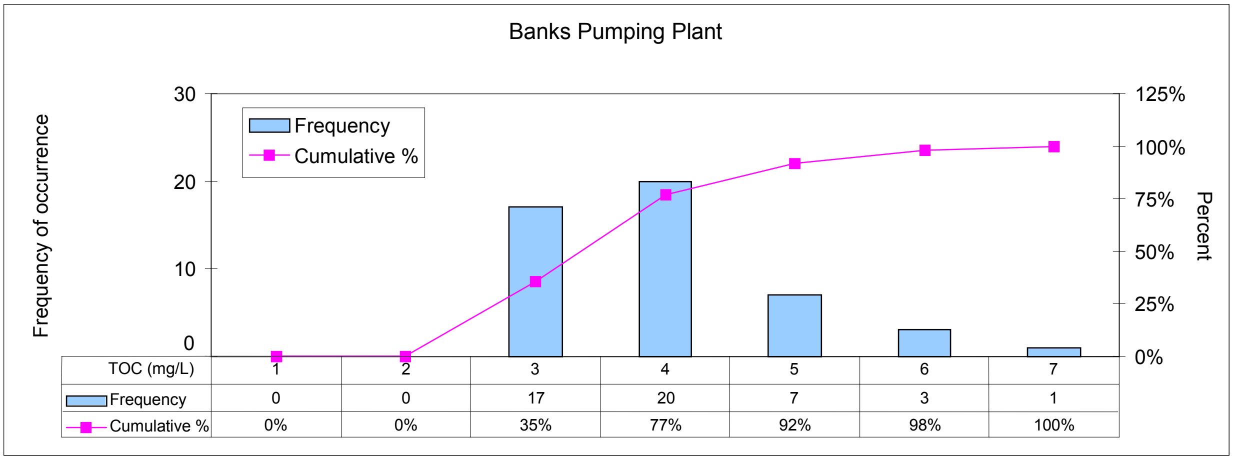
TOC concentrations at Banks Pumping Plant are similar to SBA influent at the WTPs (Table 5-11, Figure 5-11). Since TOC is analyzed weekly at ACWD's WTP1 and monthly at Banks Pumping Plant, the TOC distribution at WTP1 provides a more complete view of carbon levels originating from Banks. WTP1 was included because ACWD uses chlorination for disinfection there. Cumulative probability distributions at WTP1 illustrate that from 1996 through 1999, approximately 30% of all TOC detections met the proposed CALFED TOC target level at the pumps of 3 mg/L (Figure 5-11). The majority of TOC detections occurred between 3 and 4 mg/L with approximately 25% of all carbon concentrations detected above 4 mg/L. In TOC and alkalinity ranges, Table 5-12 shows the required percent removal of TOC under the Stage 1 D/DBP Rule.

Table 5-11 Bromide, TOC, and Alkalinity Concentrations (mg/L) at the Banks Pumping Plant and Selected South Bay Aqueduct Water Treatment Plants, 1996 to 1999

Analyte	Location	Mean	Median	Min	Max	Percentile Range (10-90%)	# Detects/ Total Sampled
Bromide (mg/L)	Banks Pumping Plant[a]	0.15	0.12	0.04	0.52	0.06 - 0.29	48/49
	Penitencia WTP[b]	0.14	0.11	< 0.05	0.47	0.05 - 0.24	46/56
	Del Valle WTP[a]	0.17	0.1	< 0.05	0.6	0.06 - 0.35	36/49
	Patterson Pass WTP[a]	0.21	0.1	< 0.05	0.9	0.06 - 0.42	45/48
	WTP2[c]	0.11	0.09	< 0.003	0.51	0.03 - 0.24	200/206
TOC (mg/L)	Banks Pumping Plant[a]	3.5	3.2	2.3	6.7	2.7 - 4.9	47/48
	Penitencia WTP[b]	2.8	2.6	1.8	4.9	2.2 - 3.3	45/45
	Del Valle WTP[a]	3.0	2.9	1.9	4.3	2.3 - 3.9	44/44
	Patterson Pass WTP[a]	2.9	2.7	1.9	4.8	2.1 - 4.2	43/43
	WTP1[c]	3.6	3.4	2.3	6.4	2.8 - 5.0	189/189
	WTP2[c]	3.6	3.4	2.3	6.4	2.7 - 5.1	205/205
Alkalinity (mg/L)	Banks Pumping Plant[a]	61.9	62	33	95	48 - 74	69/69
	Penitencia WTP[d]	77	67	13	148	48 - 120	880/880
	Del Valle WTP[a]	82	73	41	137	55 - 121	49/49
	Patterson Pass WTP[a]	66	65	38	111	50 - 82	48/48
	WTP1[a]	88	84	42	152	55 - 132	20/20
	WTP 2[a]	92	84	40	152	60 - 134	21/21

[a] Averages based on monthly data Jan 1996 to Dec 1999.
[b] Averages based on monthly data Jan 1996 to Dec 1999. Data not used if source water not identified or from San Luis Reservoir.
[c] Averages based on weekly data Jan 1996 to Dec 1999.
[d] Averages based on daily data.
WTP = water treatment plant
Summary Statistics calculated by substituting detection limit for all values less than the detection limit.

Figure 5-11 Cumulative Probability Distribution of TOC at Banks Pumping Plant and the ACWD WTP1, Jan 1996 to Dec 1999



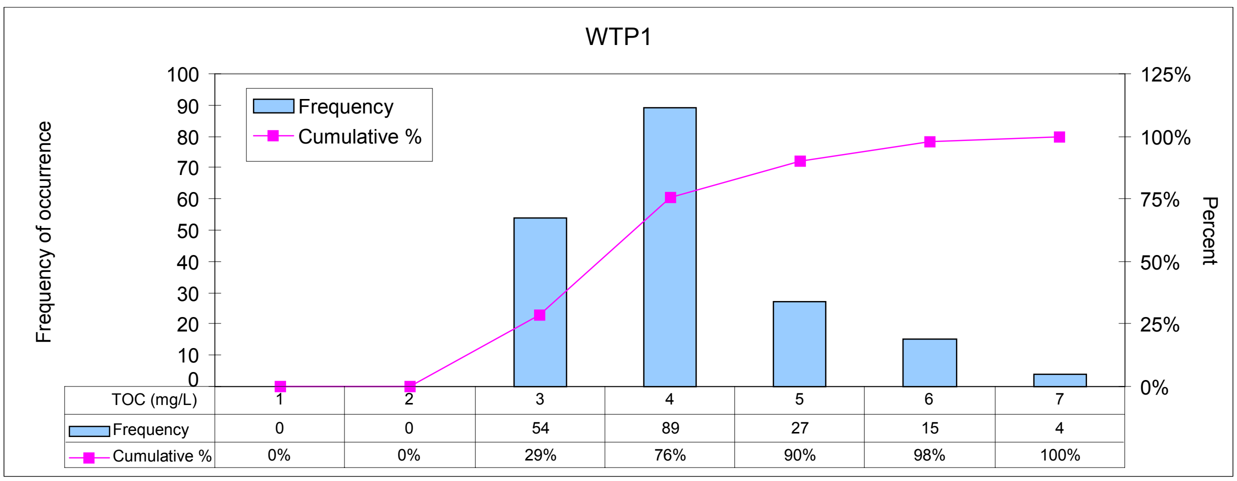


Table 5-12 Percent Removal of TOC by Enhanced Coagulation and Enhanced Softening for Systems Using Conventional Treatment

Source Water TOC (mg/L)	Source Water Alkalinity as $CaCO_3$ (mg/L)		
	0–60	>60-120	>120
> 2.0-4.0	35%	25%	15%
>4.0–8.0	45%	35%	25%
>8.0	50%	40%	30%

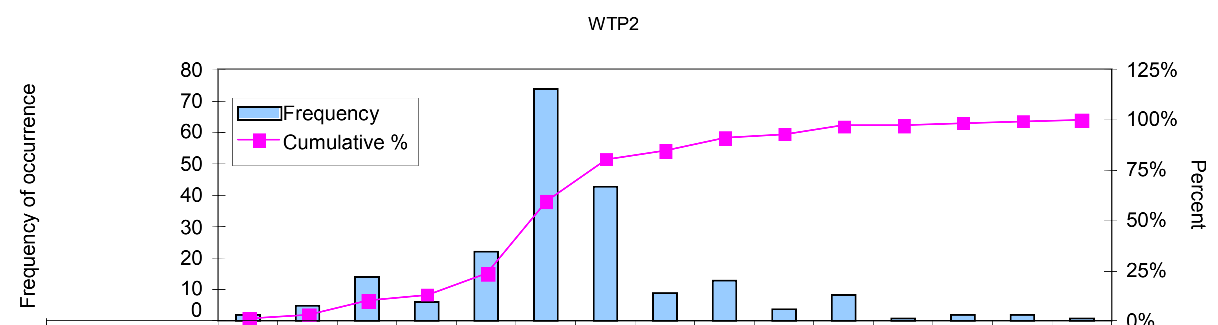
Based on 4-year averages of TOC and alkalinity, all SBA plants would require a minimum of 25% removal of TOC. Both the minimum and maximum values for TOC and alkalinity suggest that depending on the paired combination of these 2 variables, SBA plants may need to remove as much as 45%, or as little as 15% of their incoming TOC. SBA contractors have expressed concerns about meeting the Stage 1 TOC removal requirements (Zone 7 2000; SCVWD 2000). One treatment strategy employed by Zone 7 uses $FeCl_3$ instead of $AlSO_4$ as a coagulant when needed. The use of $FeCl_3$ is much more expensive than $AlSO_4$, but it provides better TOC and particulate removal.

Bromide

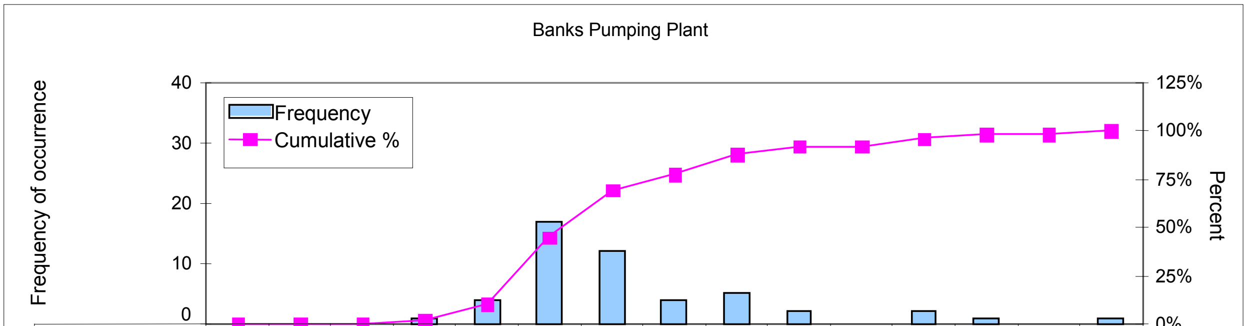
Recipients of SBA water are some of the 1st contractors to receive water from Banks Pumping Plant via the California and South Bay aqueducts. Because it is unlikely there are additional sources of bromide within the SBA watershed, it is reasonable to assume that bromide concentrations experienced by SBA plants are a reflection of those exported from Banks Pumping Plant. To prevent problems associated with bromate formation from ozonation, CALFED has suggested target levels of 50 µg/L for bromide concentrations at the export pumps (DWR 2000c).

Like TOC, bromide concentrations at Banks Pumping Plant are similar to those in SBA influent at the WTPs (Table 5-11). An analysis of water quality data using frequency distributions supports the idea that bromide concentrations at Banks Pumping Plant and in SBA plant influent are similar. Bromide concentrations are analyzed weekly at ACWD's WTP2 while bromide samples are collected monthly at Banks Pumping Plant. Based on the different sampling frequencies, actual cumulative percentages between the 2 sites varied; however, the shapes of the bromide distributions were nearly identical (Figure 5-12). At both locations, bromide was detected the most frequently between 0.05 and 0.1 mg/L, followed by detections between 0.1 and 0.15 mg/L. Bromide summary statistics for all SBA WTPs evaluated are shown in Table 5-11. Although sampling dates and frequencies differ between the plants—and in some cases values were not used when a different source water was online, for instance, Penitencia WTP—bromide concentrations recorded at the treatment plants and at Banks Pumping Plant were extremely consistent.

Figure 5-12 Cumulative Probability Distribution of Bromide (mg/L) in Source Water at ACWD WTP2 and Banks Pumping Plant, Jan 1996 to Dec 1999



Bromide (mg/L)	0.01	0.02	0.03	0.04	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5	0.51
Frequency	2	5	14	6	22	74	43	9	13	4	8	1	2	2	1
Cumulative %	1%	3%	10%	13%	24%	60%	81%	85%	91%	93%	97%	98%	99%	100%	100%



Bromide (mg/L)	0.01	0.02	0.03	0.04	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5	0.52
Frequency	0	0	0	1	4	17	12	4	5	2	0	2	1	0	1
Cumulative %	0%	0%	0%	2%	10%	45%	69%	78%	88%	92%	92%	96%	98%	98%	100%

5.4.2.3 Disinfection Byproducts (Total Trihalomethanes, Haloacetic Acids, and Bromate)

Depending on the treatment process and the plant, SBA contractors cite DBPs formed from both TOC and bromide in SBA source water as their major water quality concerns. From 1996 to 1999, the ACWD WTP2 was the only SBA plant using ozone; therefore, bromate formation was only examined at this SBA plant. The SCVWD is in the process of upgrading plants to use ozone, so they also are concerned with meeting bromate regulations.

Based on survey information and discussion with laboratory and operations staff, Zone 7 has no problems meeting Stage 1 TTHM or haloacetic acids (HAA5) D/DBP MCLs (Zone 7 2000; Deol, pers. comm. 2001; Baker pers. comm. 2001). HAA5 is a group of regulated haloacetic acids: monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid and dibromoacetic acid. Depending on the operations of Zone 7's retail water systems, the continued formation of THMs may be an issue. All SBA users reported concern with TOC and/or the production of THMs or HAAs and are in the process of either optimizing or upgrading their treatment processes (ACWD 2000; SCVWD 2000).

Average quarterly and annual TTHM concentrations for the SBA WTPs are shown in Table 5-13. From 1996 through 1999, the annual averages of all WTPs were below the 80 µg/L MCL of the Stage 1 D/DBP Rule. No appreciable pattern appeared between the season and THM formation. However, in 1997 the annual average of WTP1 came close to exceeding the MCL, and the plant exceeded the MCL in 2 of the 4 quarters of that year (April to June at 83 µg/L and October to December at 87 µg/L). None of the other WTPs showed similar increases. Because of the frequency of analyses, it is not known whether higher TTHMs occurred at

WTP1. WTP1 analyzes for TTHMs weekly, while Penitencia analyzes monthly and Zone 7 analyzes quarterly. In both 1996 and 1997, WTP1 generally had higher values than other SBA plants, but in 1998 and 1999 this was not the case. This may indicate that the nature of the carbon was less variable in 1998 and 1999. However, if this were the case, then values would be similar between plants, regardless of the sampling frequency. WTP2 uses ozonation for disinfection. Therefore, its corresponding TTHM production was relatively low with respect to other SBA plants.

Table 5-13 Average Quarterly and Annual TTHM Concentrations (μg/L) by Year for Selected SBA Water Treatment Plants

		Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Annual Avg
1996	Penitencia WTP	67	63	33	52	54
	Del Valle WTP[a]	71	56	45	66	60
	Patterson Pass WTP[a]	83	59	48	59	62
	WTP1	76	69	70	55	67
	WTP2	9	3	3	15	8
1997	Penitencia WTP	53	50	57	56	54
	Del Valle WTP[a]	71	39	45	50	51
	Patterson Pass WTP[a]	52	61	47	61	55
	WTP1	70	83	73	87	78
	WTP2	4	7	8	23	11
1998	Penitencia WTP	67	56	52	53	57
	Del Valle WTP[a]	39	55	37	44	44
	Patterson Pass WTP[a]	52	84	42	36	54
	WTP1	63	52	55	45	54
	WTP2	8	12	12	17	12
1999	Penitencia WTP	OL	OL	52	68	60
	Del Valle WTP[a]	38	36	45	47	42
	Patterson Pass WTP[a]	43	56	48	60	52
	WTP1	46	53	55	60	54
	WTP2	7	5	4	11	7

[a] Quarterly values represent samples collected once/quarter, not an average of samples collected monthly.
OL = off-line
WTP = water treatment plant

Although Penitencia WTP's annual averages have always been below the Stage 1 MCL, it had several quarters in which TTHMs approached 70 µg/L. This creates a potential THM problem for the district's client agencies. Depending on a client's water delivery infrastructure, there is the potential for continued formation of THMs. Water quality data from client agencies to the SCVWD were not reviewed in this update, so it is unknown whether the infrastructure of the district's client agencies could potentially allow concentrations to exceed Stage 1 regulations. Zone 7's TTHM water quality is similar to other SBA WTPs. Within the distribution system of Zone 7's client agencies, TTHM concentrations average about 50 µg/L (O'Brien pers. comm.2001a), which are similar to Zone 7's and below the MCL.

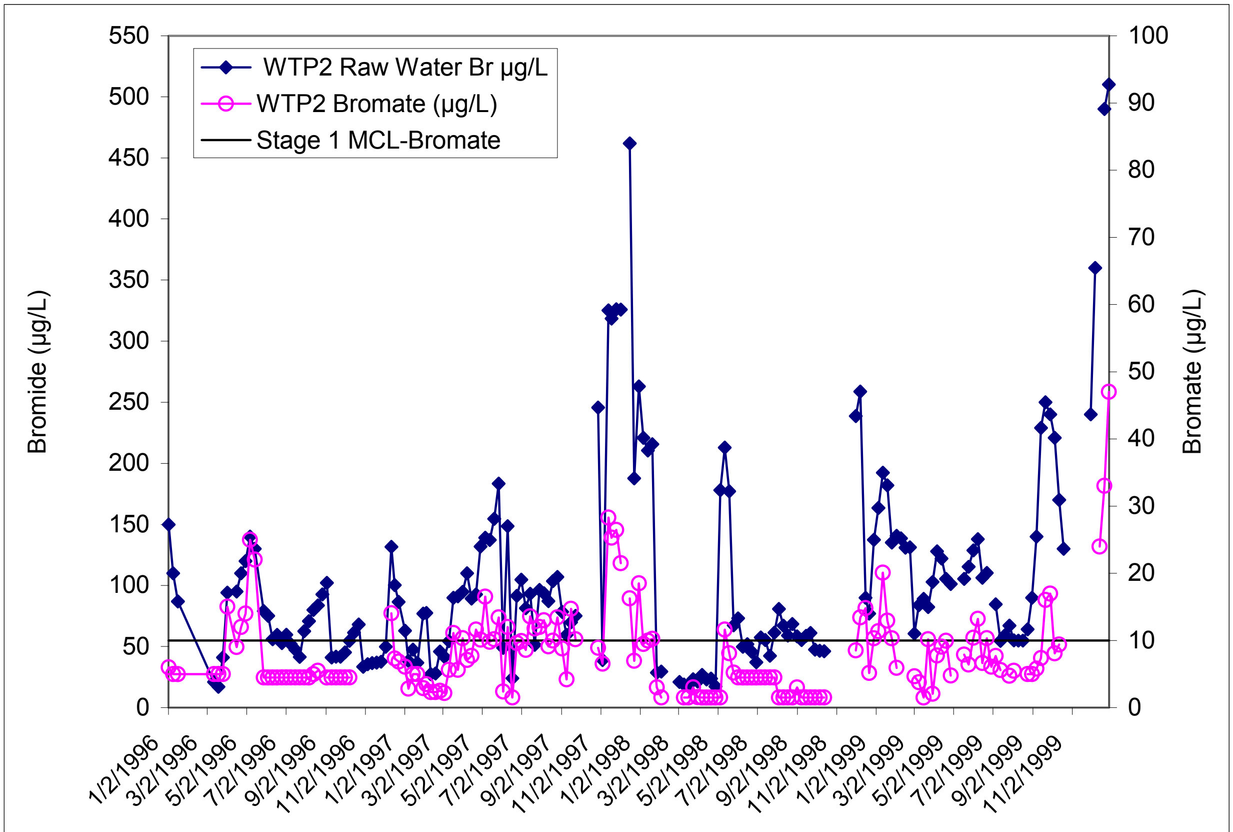
Average quarterly and annual HAA5 concentrations for selected SBA WTPs are shown in Table 5-14. From 1996 through 1999, all running annual averages were below the 60 µg/L MCL of the Stage 1 D/DBP Rule. At WTP1, quarterly HAA5 concentrations reached the MCL in the January to March quarter of 1997. Throughout 1997, WTP1 experienced high TTHM levels in all quarterly TTHM averages (Table 5-13), although that was not the case for the plant's HAAs levels in 1997. Zone 7 began testing for HAAs in April 1998. As noted earlier, the utility does not consider HAA5 to be a treatment problem for its plants. As with other plants during the same time period, its Del Valle and Patterson Pass WTPs were well below the 60 µg/L MCL. Concentrations of HAA5 in the distribution system of Zone 7's client agencies average around 20 µg/L (O'Brien pers. comm. 2001a). These values are similar to Zone 7's averages and are below the MCL. Available data suggest that SCVWD's Penitencia WTP also experienced low HAA5 concentrations when using only SBA water.

Table 5-14 Average Quarterly and Annual HAA5 Concentrations (µg/L) by Year for Selected SBA Water Treatment Plants

		Jan -Mar	Apr -Jun	Jul -Sep	Oct -Dec	Annual Avg.
1996	Penitencia WTP[a]	UA	UA	10	UA	-
	Del Valle WTP[b]	-	-	-	-	-
	Patterson Pass WTP[b]	-	-	-	-	-
	WTP1	52	39	34	36	40
	WTP2	8	2	2	9	5
1997	Penitencia WTP[a]	UA	UA	UA	UA	UA
	Del Valle WTP[b]	-	-	-	-	-
	Patterson Pass WTP[b]	-	-	-	-	-
	WTP1	60	33	34	34	40
	WTP2	8	5	5	7	6
1998	Penitencia WTP[a]	UA	UA	31	22	27
	Del Valle WTP[b]	-	37	NS	21	29
	Patterson Pass WTP[b]	-	37	NS	18	28
	WTP1	42	30	32	24	32
	WTP2	9	5	5	4	6
1999	Penitencia WTP[a]	NS	NS	32	26	29
	Del Valle WTP[b]	14	20	25	8	18
	Patterson Pass WTP[b]	21	27	22	10	20
	WTP1	19	35	23	22	25
	WTP2	8	4	4	8	6

[a] Calculations made only when source water was identified as SBA or DV
[b] Quarterly values represent samples collected once/quarter, not an average of samples collected monthly. Sample collection started in Apr 1998.
UA = source water not specified, or data not collected. NS = not sampled DL substituted for values <DL

Figure 5-13 Influent Bromide and Treated Water Bromate Concentrations at ACWD WTP2, Jan 1996 to Dec 1999



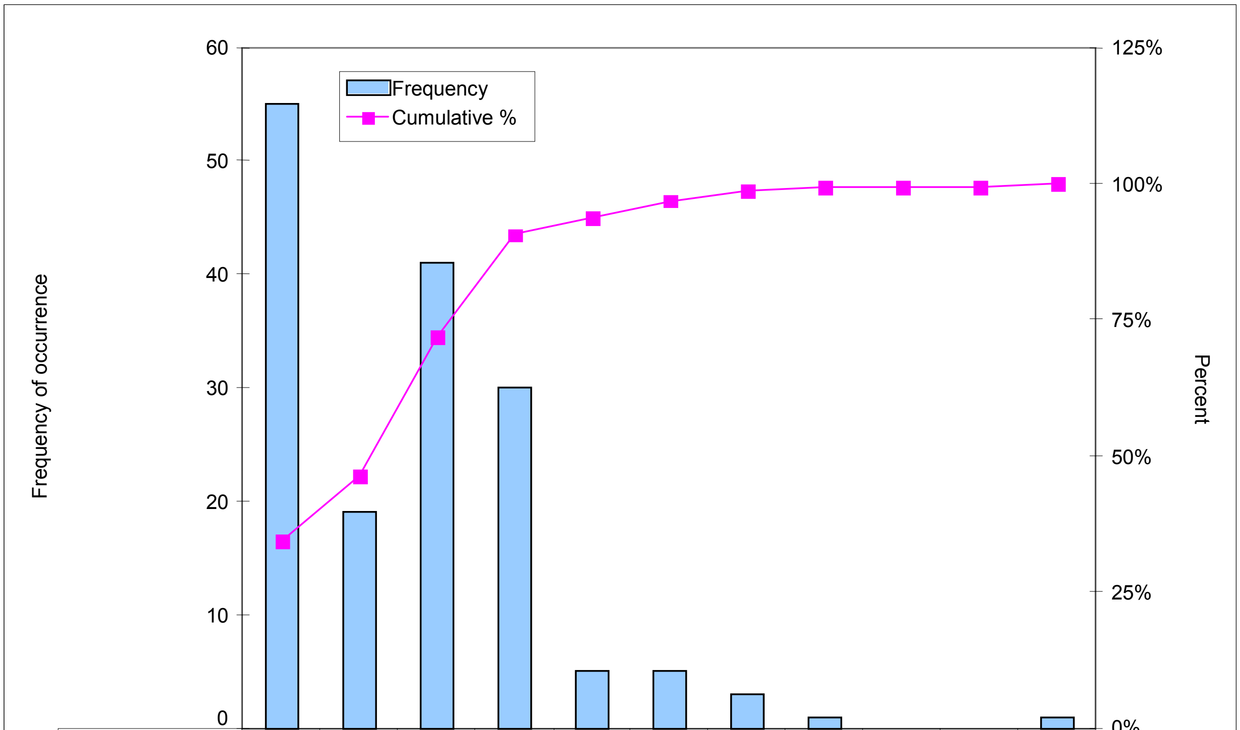
Values < DL changed to DL.
Spaces represent the plant off-line or use of non-SBA water.

Of all bromide samples of SBA source water analyzed at WTP2, approximately 75% were above CALFED's proposed target level of 50 µg/L (Figure 5-12). Ozonation of these bromide concentrations frequently (but not always) produced bromate concentrations above the Stage 1 D/DBP bromate MCL of 10 µg/L (Figure 5-13). Cumulative probability calculations illustrate that while a third of all weekly samples collected at WTP2 were below the detection limit, approximately a quarter of all samples collected were above the bromate MCL (Figure 5-14). Actual bromate compliance is based on the running annual average, computed quarterly, of monthly samples (or average of all samples taken during the month if more than 1 sample was collected). If the average of samples covering any consecutive 4-quarter period exceeds the MCL, the system is in violation (EPA 2001). From 1996 through 1999, bromate quarterly averages at WTP2 have exceeded the MCL at least once between April and December (Table 5-15, Figure 5-15). Of the 4 years evaluated, the running annual average for WTP2 exceeded the bromate MCL in 2 of the 4 years evaluated (1997 and 1999). Overall, the highest bromate concentrations have tended to occur in the winter with the highest recorded value (47 µg/L) occurring in December 1999 (Figure 5-13). High bromate concentrations were unexpectedly observed in winter months. Bromate and bromide concentrations would be expected to increase during drought or below-normal rainfall periods.

Table 5-15 Average Quarterly and Annual Bromate Concentrations (µg/L) by Year at the ACWD WTP2

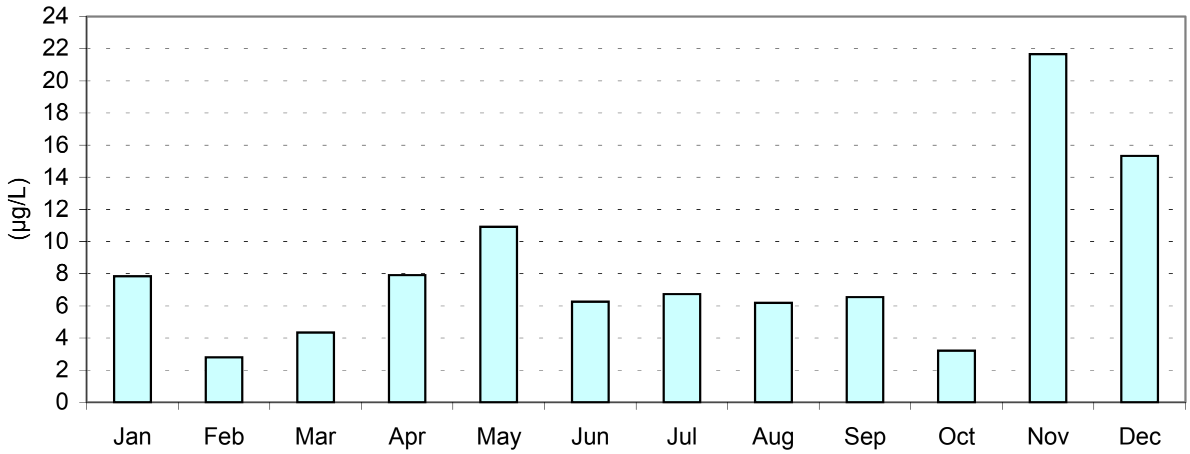
	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Annual Avg.
1996	5.2	10.9	4.6	7.4	7.0
1997	4.4	9.4	10.7	17.2	10.4
1998	4.3	4.2	2.6	7.9	4.8
1999	8.3	8.4	8.0	22.1	11.7

Figure 5-14 Cumulative Probability Distribution of Bromate at ACWD WTP2, Jan 1996 to Dec 1999



Bromate (µg/L)	0	5	10	15	20	25	30	35	40	45	50
Frequency	55	19	41	30	5	5	3	1	0	0	1
Cumulative %	34%	46%	72%	91%	94%	97%	99%	99%	99%	99%	100%

Figure 5-15 Monthly Average Bromate Concentrations Between 1996 and 1999 at the ACWD WTP2



In 2001, the ACWD will be upgrading its WTP2 plant to allow acid addition to lower pH and bromate formation. The cost for this improvement is estimated at $1 million (Chun pers. comm. 2001). Although none of the other SBA plants evaluated is using ozone, the SCVWD is upgrading its plants to include ozonation (SCVWD 2000). The district's summary statistics suggest that the upgraded plants as well as any other plant using ozone and SBA water will encounter the same challenges with bromate formation as observed at WTP2. Like the ACWD, the SCVWD plans to use acid addition to control bromate formation (Matthews pers. comm. 2001).

In conclusion, at the 3 plants that have indicated bromate treatment problems (Penitencia and WTPs 1 and 2), the respective agencies are in the process of upgrading their plants to limit the formation of DBPs. The ACWD is in the process of a $1 million upgrade of its WTP2 plant that will allow the addition of acid to limit the formation of bromate. At the SCVWD, all plants are being converted to ozone and will use acid addition to control bromate formation.

5.5 SIGNIFICANCE OF POTENTIAL CONTAMINANT SOURCES

The DBP precursors TOC and bromide are 2 major water quality concerns for all SBA contractors because of their presence in SBA source water. These 2 constituents present significant water treatment challenges in meeting future drinking water regulations. Taste and odor issues because of algae in SBA source water have also been a recurring problem for SBA contractors.

Although Zone 7 and its retail water system should be able to meet both Stage 1 and proposed Stage 2 TTTM and HAA5 MCLs, Zone 7 plans to optimize its disinfection and TOC removal processes to further lower the level of DBPs. Also, by the end of 2002, all Zone 7's retail water systems will be using chloramines as the disinfectant residual in their distribution systems, which will limit the formation of DBPs. At the 3 plants that have indicated treatment problems (Penitencia, WTP1 and WTP2), the respective agencies are in the process of upgrading to limit the formation of DBPs.

5.5.1 SOUTH BAY AQUEDUCT

Cattle grazing and algal blooms were the most significant PCSs for the SBA. Grazing could be a significant potential source of pathogens and nutrients. Algal blooms can cause treatment problems, such as filter clogging, and chemical taste and odor problems. Recreation, wastewater treatment/facilities, and urban runoff posed a minimal threat to water quality and were not found to be significant PCSs. There is a substantial amount of agriculture around the SBA, including vineyards, but the majority appears to be out of the immediate drainage area of the SBA, most agricultural activities are farther west and north. Based on their locations, these agricultural activities are considered a minor threat to water quality.

Cattle are grazed along the open portions of the SBA. One route of contamination is runoff from surrounding hillsides, which can enter the open portions of the SBA through drain inlets, overcrossings, and bridges. A 2nd route of grazing contamination was wooden bridges used by cattle to cross the aqueduct. Large gaps between the wooden planks on these bridges allowed cattle droppings to directly enter the aqueduct. These planks have been replaced with sealed flooring to reduce the threat to water quality.

A significant water quality concern consistently cited by all SBA contractors is the taste and odor problem resulting from algal production of the offensive taste and odor compounds MIB and geosmin. Although algal growth was observed in the aqueduct, algae thought to be responsible for most of the taste and odor problems originate in the Delta and not in the SBA. These algae continue to grow in the SBA open canal especially under the right water temperature and light conditions, generally during summer months.

Following implementation of the new copper sulfate treatment procedure described in Section 5.3.1.5, Algal Blooms, all SBA plants evaluated in this report noted an improvement with taste and odor in summer 2000. While encouraging, more data are required before determining the success of this procedure. It is possible that algal numbers in summer 2000 were naturally low; therefore, taste and odor issues would not have been a concern, regardless of copper sulfate applications. Comparisons between algal numbers or taste and odor constituents at Banks Pumping Plant relative to the SBA will have to be examined over several summer bloom seasons to determine the efficacy of this treatment strategy. The new DWR copper sulfate-dosing regime appears promising, but further study is required before its success can be fully determined.

5.5.2 Lake Del Valle

Recreation, grazing, and algal blooms are the most significant PCSs in the Lake Del Valle watershed. Wastewater treatment facilities and erosion related to land use changes could pose threats to water quality, but they were not found to be problems during this survey period.

Recreation activities at Lake Del Valle present a moderate threat to water quality. Body contact recreation and boating are potential sources of *Giardia* and *Cryptosporidium* in the lake. Pathogen issues for SBA contractors who use a combination of Lake Del Valle and SBA source water are discussed in Chapter 12. Boating is a major recreational activity at Lake Del Valle. Most boating activity occurs from May to October. The primary water quality concern associated with boating is MTBE contamination from motorized watercraft. MTBE contamination appears greatest near the boat ramp area and decreases with distance. Activities in and around campground areas, especially those near the water line, along trails, and parking areas can contribute to soil erosion and can cause increased turbidity in the lake.

The Del Valle watershed has a long history of extensive cattle-grazing operations around the edge of the lake, the dam area, and in the upper watershed. Cattle have historically had access to the lake but typically not from June through October when grass is scarce. There is some fencing, mostly around recreation areas, but much of the grazed lands are unfenced to the lake. Installation of fencing to keep cattle from reaching the lake is limited because of the high cost. Although grazing occurs in the SBA/Lake Del Valle watershed, water is normally not drawn from the reservoir until late summer/fall. Flushing of contaminants from the watershed into the lake occurs in the winter when Lake Del Valle water is generally not released to contractors. This may explain the relatively low fecal and *E. coli* bacteria counts observed at water treatment plants when Lake Del Valle water was utilized (see Chapter 12 for pathogen issues). There is a substantial wild animal population present, but because of the extensive undeveloped and rugged nature of the watershed, little is known of actual numbers of animals and their condition. Droppings from wild animals are a potential source of pathogens in the watershed during rainfall and have been reported by contractors as a water quality concern.

Nuisance algal growth has been a historical occurrence at Lake Del Valle and presents a moderate threat to water quality. The primary water quality problems associated with algal blooms are increased turbidity, which affects plant operations, and taste and odor resulting from production of MIB and geosmin. A primary cause of algal blooms in Lake Del Valle and the SBA is the high nutrient load in source water from the Sacramento/San Joaquin Delta. Local potential nutrient sources within the lake watershed (grazing and wild animals, sewage spills, internal lake recycling) may also be significant contributors to algal blooms. However, the relative contribution of SBA/Delta source water and watershed sources to the reservoir's algal blooms is not known.

An unknown amount of sewage was released into the Lang Canyon inlet on 24 May 1998. There was a sewage spill from a septic line lift station into the Lang Canyon stream inlet to Lake Del Valle. EBRPD staff reported that the spill was stopped and booms were installed around the area of the spill. Except for this 1 spill, the wastewater lagoons and all associated systems within the area operated properly within the report period. However, since the potential exists for spills or system failures to contribute pathogens, organic carbon, and nutrients to the lake, these activities may pose a moderate threat to water quality.

The Lake Del Valle watershed is highly susceptible to erosion. About 80% of the land in the drainage basin is classified as a severe erosion hazard because of its shallow soils and steep slopes. Because of these conditions, the Lake Del Valle watershed is extremely sensitive to land use changes such as urbanization and development. Arroyo Valle has deposited some 20,000 cubic yards of silt in the reservoir since the dam was built. The sediment load from the creek can cause elevated turbidities in the lake. Even limited land use changes such as construction of access roads or grading for construction, if not carefully planned, could accelerate soil erosion and/or landslide problems. Because of this, the watershed is very vulnerable, and there is a substantial potential threat to water quality if significant land use changes were to occur in the basin.

The primary agricultural activity in the watershed is livestock production. Because of the location and type of terrain prevalent in the watershed, other types of agricultural development are extremely limited. There are no herbicides or pesticides used in the lake. The herbicide Roundup is used, and Surflan is also used as a pre-emergent herbicide for terrestrial weeds. This potential contaminant source presents minimal threat to water quality.

5.6 WATERSHED MANAGEMENT PRACTICES

With 1 exception, there are no known watershed management programs in the Lake Del Valle watershed. This may be because much of the watershed area is private property. In contrast, the EBRPD actively manages the Lake Del Valle SRA. Much of its activity is focused on grazing management. In 1992, the EBRPD adopted Wildland Management Policies and Guidelines that further refined the program, establishing the current process of using grazing as a tool to maintain and enhance plant and animal resources and minimize fire hazards. The guidelines state:

> “The District will conserve, enhance, and restore biological resources to promote naturally functioning ecosystems. Conservation efforts may involve using controlled grazing, in accordance with Wildland Management Policies and Guidelines, prescribed burning, mechanical treatments, integrated pest management, and/or habitat protection and restoration. Restoration activities may involve the removal of invasive plants and animals or the reintroduction of native or naturalized species adapted to or representative of a given site.”

The 1997 EBRPD Master Plan continued this process, providing that the district manages grazing in accordance with the Wildland Management Policies and Guidelines. The district also evaluates other vegetation management alternatives for their costs, benefits, and applicability to specific site conditions. The district policies and guidelines further proposes modifications to program practices, guidelines and/or management activities to achieve resource management and recreational use objectives.

A watershed management program (WMP) should be initiated at Lake Del Valle to coordinate existing and future watershed management activities and studies. Several contaminant sources and related water quality issues—for example, recreation/grazing and pathogens, boating and MTBE, algae and taste and odor—are of concern in the SBA and Lake Del Valle. Evaluation of these issues would greatly benefit from such an integrated WMP approach. As part of the implementation of the WMP, a watershed coordinator position should also be established to monitor land use changes and to work with landowners and agencies to encourage planning and land use practices that protect water quality. Any personnel working for the WMP should act as contacts for information on all watershed management practices and provide a clearinghouse of watershed information (recreational use, cattle-grazing, wastewater facilities operation, etc.).

A comprehensive study should be made of the major sources of nutrients to Lake Del Valle and the SBA. The study should address algal dynamics and nutrient cycling within the major reservoirs to better understand the processes controlling algal populations. This study should also coordinate with and include, if applicable, other studies undertaken for pathogens, MTBE, or other contaminants. Other studies should include but not be limited to:

- An evaluation of grazing practices along the SBA and in the Lake Del Valle watershed to involve private landowners who graze cattle in these areas, and
- An evaluation of the relationship between grazing and pathogen loading and its effects on water quality.

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